

C + M

CITY OF HAVRE
SOLID WASTE LANDFILL
LICENSE APPLICATION

RECEIVED

MAR 07 1995

Montana Department of Health
and Environmental Sciences
Waste Management Division



DAMSCHEN & ASSOCIATES, INC.

CONSULTING ENGINEERS

• HELENA, MONTANA •



D
SA
DAMSCHEN & ASSOCIATES, INC.

CONSULTING ENGINEERS

[minutes] contain?
signs

HELENA, MT 59601
TELEPHONE (406) 433-0877
FAX (406) 433-0551

March 6, 1995

Jim Wilcox
Department of Health & Environmental Sciences
Solid & Hazardous Waste
Coyneville Building
Helena, MT 59620

CITY OF HAVRE

SOLID WASTE LANDFILL LICENSE APPLICATION

Dear Jim:

Enclosed are two (2) copies of the necessary information and
operation plan to apply for a Class III landfill license for the
City of Havre. The site is located approximately 1 mile south of
Havre.

We appreciate your providing this information. If you have any questions or comments, please contact us at your earliest convenience.

Prepared For:

HAVRE, MONTANA

Yours very truly,

DAMSCHEN & ASSOCIATES, INC.

Submitted To:

Montana Department of Health
and Environmental Sciences
Waste Management Division

BBJ/kab

Enclosure

cc: City of Havre

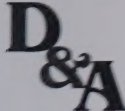
February, 1995

Prepared By:
DAMSCHEN & ASSOCIATES, INC.
Helena, Montana

RECEIVED

MAR 07 1995

Montana Department of Health
and Environmental Sciences
Waste Management Division



DAMSCHE & ASSOCIATES, INC.

CONSULTING ENGINEERS

2030 11TH AVENUE • SUITE 11
P.O. BOX 4817 • HELENA, MT 59604

TELEPHONE (406) 449-8627
FAX (406) 449-8631

March 6, 1995

Jim Wilbur
Department of Health & Environmental Sciences
Solid & Hazardous Waste Bureau
Cogswell Building
Helena, MT 59620

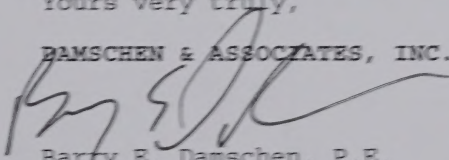
Dear Jim:

Enclosed are two (2) copies of the necessary information and operation plan to apply for a Class III landfill permit for the City of Havre. The site is located approximately 1 mile north of Havre.

We appreciate your timely assistance and review of this information. If you have any questions or comments, please call me at your earliest convenience.

Yours very truly,

DAMSCHE & ASSOCIATES, INC.


Barry E. Damschen, P.E.
Project Manager

BED/kmh

Enclosure

cc: City of Havre

TABLE OF CONTENTS

- A. Background
- B. Service Area
- C. Site Plan
- D. Hydrogeology of Site
- E. Waste Characteristics & Site Life
- F. Operation Plan
 - 1. Responsibilities
 - 2. Schedule
 - 3. Labor Requirements and Equipment Requirements
 - 4. Road Maintenance
- G. Landfill Closure

Appendix A - Application Form

Appendix B - Hydrogeological Report

Appendix C - Plan Sheets (Detached)

CITY OF HAVRE

LANDFILL LICENSE MODIFICATIONS

ops plan very
clear?

A. Background

The old Havre landfill stopped receiving wastes in the early 1980's when the Unified Disposal District landfill was opened. The closure work will be finalized in the spring of 1995. The closure plans are attached as a part of this submittal. The present and long range disposal plan for the City of Havre includes hauling the Class II wastes to the Unified Disposal District's Class II landfill located approximately 10 miles east of Havre.

The location of the proposed Class III burn pit area is on the same tract of land as the previously operated Class II landfill. This Class III license application is requesting the right to burn Class III (tree branches and untreated wood) wastes. As indicated on the attached plans, the site is located approximately 1 mile north of Havre.

B. Service Area

The service area for the Class III site will be the City of Havre. The estimated population to be served at this facility is approximately 10,000 people. Approximately 11,000 tons per year of waste are being generated in the City. It is anticipated that approximately 15% or 1,650 tons of this waste is Class III burnable materials and correspondingly will be disposed of in the Class III burn pit each year.

C. Site Plan

The attached plan sheet depicts the layout of the proposed facility at the site. The proposed Class III site burn pit will include utilizing an existing open pit with approximate dimensions of 300' by 200' by 12' deep. To access the site, the existing gravel roads will be improved where necessary from the gate to the new Class III burn pit area. Care will be taken to not disturb the closed Class II site and the drainage system. Access to the facility will be limited by the use of existing gates and fences.

D. Hydrogeology of Site

In February, 1994, Damschen & Associates Inc. conducted a preliminary hydrogeologic investigation of the wastewater sludge ponds located on-site. Based on this investigation, the following hydrogeologic conditions are present at the site. A more detailed description of that investigation is contained in Appendix B.

Depth to Ground Water: Ground water lies within several geological formations in the area. Domestic well logs show ground water occurring in association with the alluvial deposits in the Milk River valley and in the underlying Judith River formation. The static water level within the alluvial deposits is between 2,455 and 2,465 feet above mean sea level (MSL). Ground water occurs in the Judith River formation in sandstone strata that range in elevation from 2,365 feet MSL northwest of the site to 2,320 feet MSL east of the site.

In addition to these two aquifers, small quantities of water lie perched in sand bodies within the glacial drift that mantles the entire region. These glacial drift aquifers are generally small in scale and aerial extent, and are commonly isolated, hydrologically speaking. A sand body containing ground water was discovered on the northern portion of the facility. Subsequent work at the ponds has shown that the ground-water gradient dips to the northeast and that no ground water occurs south of the facility. This information is described in detail in the attached report, which is labelled as Appendix B.

The contact of the glacial drift with the underlying Judith River formation is exposed along the entrance road to the proposed Class III landfill site. Likewise, the static water level in the monitoring well just west of the sludge ponds and north of the proposed Class III site lies at an elevation that would be exposed at the surface to the southwest. Therefore, it is obvious that the ground water encountered north of the landfill site is not continuous throughout the area.

Since the glacial drift aquifer appears to be limited to a relatively small area north of the proposed Class III landfill, and since the site is nearly one-quarter of a mile distant from and 50 feet higher in elevation than the nearest alluvial deposit, the closest ground water is associated with the Judith River formation aquifer. The water-bearing formation within the Judith River lies at approximately 2,330 feet MSL, some 270 feet below the ground surface.

E. Waste Characteristics & Site Life

Untreated wood and tree wastes will be hauled to the site and burned periodically. The ashes will be hauled to the Unified Disposal District (Class II) landfill referenced above.

It is anticipated that approximately 31,000 cubic yards of material will be burned annually at this site. The life for this Class II burn pit area could be indefinite considering that the ashes will be removed periodically.

The following wastes will not be allowed at the facility:

- a) Class II wastes
- b) Large dead animals
- c) Sewage or other sludge
- d) Asbestos
- e) Liquids of any type
- f) Hazardous wastes
- g) Concrete
- h) Rubble
- i) Tires

The City of Havre will insure sufficient funding to train and educate staff in all aspects of waste identification and record keeping.

F. Operation Plan

1. Responsibilities

The City of Havre Public Works Department will be responsible for the operation of the Class III burn pit site. The operation will be directed through the Public Works Director's office.

2. Schedule

Currently it is the intent to keep the Class III burn pit site open to the public on a limited basis. All residents and businesses in the City will be allowed to use the facilities. The site is fenced with barbed wire and the gate will be locked when closed. City of Havre personnel will unlock the gate upon the request of individuals hauling acceptable burnable materials to the site.

3. Labor Requirements & Equipment Requirements

The facility will employ qualified personnel to perform all necessary functions. Once every six months, or as needed, an attendant(s) will burn the trees and untreated wood materials. The City will acquire an air quality permit prior to each burn, with the understanding that the burn must be completed in one day. The ashes will be removed from the pit after each burn with a City of Havre front end loader, placed

in a covered dump truck or solid waste container truck and hauled to the Unified Solid Waste District landfill.

4. Road Maintenance

The City's crew will be responsible for maintaining the on-site roads at the facility. Access to the site will be via the existing City and County roads. It is anticipated that no additional impacts should occur on the access roads since the traffic using the site will be minimal.

G. Landfill Closure

Initially during the investigations, 32 test pits were excavated at the landfill site to identify the location of the wastes and the depth of cover over the wastes. As indicated on the plan sheets, the waste area encompasses approximately 20 acres. Within the 20 acres there is one isolated area where additional soil cover will be required to obtain the 2 feet of minimum soil cover over the waste (Area A on plan sheets). There is also an area which will require soil fill to allow for positive drainage (Area C on plan sheets).

To cover the waste areas and recontour the site, there is one borrow area in which soil is available and shall be obtained and is shown on the plan sheets as Area D. It is estimated that a total of approximately 7,500 cubic yards of soil will be needed to cover Area A and recontour Area C.

In regards to the re-vegetation of the site, we will be receiving a vegetation plan from the local SCS in the near future. This plan will be submitted to the Waste Management Division once the plan has been received. The plan will be implemented once the closure work is completed and the proper growing season arrives.

APPENDIX A

APPLICATION FORMS

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES



TED SCHWINDEN, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

Solid & Hazardous Waste Bureau
Telephone: (406) 444-2821

HELENA, MONTANA 59620

CHECKLIST TO INSURE THAT YOUR APPLICATION IS COMPLETE

Please number or label the attachments or enclosures that you have included with your application form and note those which are included below. (Note: Unless all the needed enclosures are included, it is unlikely that your application for a license will be considered complete.) Please return this form with your application.

- _____ 1) Copy of lease or rental agreement. (if necessary, from item #4)
- Attached 2) Map of city or county. (from item #5a)
- Attached 3) Plan of site. (from item #5b)
- Attached 4) Topographic map. (if necessary, from item #10 or item #13)
- N/A 5) Well logs, other documentation of depth to groundwater. (May be included in hydrogeological report, from item #11)
- N/A 6) Springs indicated on map. (if necessary, from item #13)
- N/A 7) Hydrogeological report. (from item #14)
- N/A 8) Groundwater Monitoring plan. (from item #15)
- Attached 9) Operation and maintenance plan. (from item #16)
- Attached 10) Cut-and-Fill plan. (from item #17)
- _____ 11) List of adjacent property owners. (from item #21)
- Attached 12) Calculations of site life. (from item #22)
- Attached 13) Closure plan. (from item #23)
- _____ 14) Indication of insurance and statement regarding liability coverage. (from item #25)

Signature of Applicant *[Signature]*Date of Completion March 1, 1995

4/88/swl

MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES
Solid & Hazardous Waste Bureau
Cogswell Building, Room B-201
Helena, Montana 59620

APPLICATION FOR A SOLID WASTE MANAGEMENT SYSTEM LICENSE

1. Name of proposed facility: City of Havre, Montana Class III landfill
Address of proposed facility: 1 mile north of Havre
Name of applicant: City of Havre
Address of applicant: Havre, Montana
Facility telephone: None Other telephone: 265-4941
2. This application is for a: ☒ solid waste disposal site, () container site (green box and bulk containers), () transfer station, () resource recovery or processing facility, () other (please specify) _____
3. a) Legal description of proposed location: SE $\frac{1}{4}$ of Sec.32, T33N, R16E
b) General description of facility location: Located approximately 1 mile north of Havre.
4. If you are not the owner of the premises, give name and address of lessor who holds title to the property and attach a copy of the lease or rental agreement. Copy attached: ☒ Yes () No
Name: William Baltrusch Address: Box 111 Havre, Montana 59501
5. Please attach the following:
a) Map of city or county showing the proposed location of facility, with indications noting adjacent residences and access roadways.
Map attached? ☒ Yes () No
b) Plan of proposed facility showing the type and adequacy of fences for litter control and access control, and location of buildings and on-site roadways. Plan attached? ☒ Yes () No
6. Total acreage of proposed site: 20 acres
Acreage usable for the solid waste system: 1.5 acres
7. Population to be served by solid waste management system: 10,200
8. Will bridges and roads support loaded vehicles? ☒ Yes () No
9. Is any portion of site within 100 year floodplain? () Yes ☒ No

10. Are natural drainages found within the site? (If "yes", indicate on map or furnish a topographic map.) ☐ Yes ☒ No

11. Depth to groundwater (attach copies of well logs and site-specific hydrogeological report): 250 feet

12. Distance from public or private water supplies (indicate locations of wells on map): 1/2 mile

13. Are there springs located within one mile of site? (If "yes", indicate locations on map.) ☐ Yes ☒ No

14. Attach hydrogeological and soil information on the proposed site, including a soil profile to a depth ten (10) to twenty (20) feet below lowest point solid waste will be deposited. Hydrogeological report attached: ☒ Yes ☐ No

15. In order to properly characterize and evaluate the impact of the proposed site on groundwater resources, it is nearly always necessary to plan a groundwater monitoring system for landfills. Usually, this plan will be prepared by a qualified consultant. Have you included such a plan for this proposed site, if the site is intended for burial of wastes? ☐ Yes ☒ No

16. Attach operation and maintenance plan. Include days and hours site open, fencing and access control, equipment used at site, how traffic will be directed and controlled, general description of solid waste management system, maintenance schedule regarding handling and disposal of solid wastes, provisions for litter control, types of waste to be accepted, proposed use of the land after fill area completed, person(s) responsible for operation and maintenance of solid waste management system. The operation and maintenance plan must indicate what measures will be taken to insure that drainage is properly handled in order to keep water from entering the waste burial area. Please refer to Administrative Rules of Montana (ARM), Rules 16.14.520 and 16.14.521 for minimum operation and maintenance requirements.
Plan attached: ☒ Yes ☐ No

17. Few sites can be properly planned or operated without a "cut-and-fill" plan. Generally, this plan must be prepared by a qualified individual with experience in landfill design. Have you included a plan of this kind with your application? ☒ Yes ☐ No

18. Will open burning of untreated wood waste be a part of the operation and maintenance plan? ☒ Yes ☐ No

19. Will any special or unusual wastes (those which require special handling or present unique environmental hazards) be accepted? ☐ Yes ☒ No

If "yes", briefly describe the wastes (use additional sheet if necessary):

20. Do you plan to accept household quantities of hazardous wastes and/or hazardous wastes from conditionally exempt generators? (Note: These types and quantities of waste may be legally accepted at state licensed "Class II" landfill facilities.) ☐ Yes ☒ No

21. Describe adjacent use of land and attach a list of names and addresses of persons owning land adjacent to the proposed facility:

Grazing- The site is surrounded by property owned by

Baltrusch Construction Co. List Attached: () Yes (x) No

22. Describe the estimated life of the facility and attach a description of the method used to calculate this figure. Description attached: (x) Yes () No
Estimated life: 50 years

23. Attach a closure plan for the landfill including final cover soil specifications, showing elevations and drainage details, revegetation requirements and other pertinent details of-site closure. Address the proposed use of the landfill upon completion. Plan attached: (x) Yes () No

24. What is the proposed opening date for this facility? Spring '95

25. Provide name and address of insurer of facility and/or attach copy of your general liability insurance policy. Provide a statement regarding the limits of the policy for sudden and non-sudden liability coverage.
Statement of Coverage attached: (x) Yes () No

Name of Insurer: Alexsis Risk Managemnt Address: Helena

26. Will underground tanks or lines be located at the site? () Yes (x) No

If "yes" have you completed EPA form 7530 (11-85) Rev. 2-86, Notification for Underground Storage Tanks? () Yes () No

If "yes", what is your facility I.D. Number? _____

27. I hereby certify that the site of the planned solid waste management system is in accordance with local government zoning and ordinances (to be signed by appropriate local government official having knowledge of local zoning ordinances).

Signature: Clay Vincent Title: Planner

Representing: Hill County Date: 3-1-95
(city or county)

I am a party responsible for operation of this proposed facility. I certify that the above described solid waste management system will be constructed and operated in accordance with Section 75-10-201 through 75-10-233, Montana Code Annotated (MCA), the rules adopted pursuant thereto, and in accordance with conditions which have or may be imposed in the license.

Signature: (to be signed by applicant) [Signature]

Title: Public Works Director Date: March 1, 1995

BALTRUSCH INC.

BOX 111
HAVRE, MONTANA 59501
PHONE 406/265-5488
1-800-447-9087
FAX 406/265-9547

February 9, 1995

BALTRUSCH CONSTRUCTION, INC.
Havre, Montana
Phone 406/265-5488

City of Havre
P O Box 231
Havre, MT 59501

BALTRUSCH TRUCK LINES
Havre, Montana
Phone 406/265-5488

ATTENTION: Gerry Grabofsky

HAVRE READY MIX
Havre, Montana
Phone 406/265-6789

Dear Gerry :

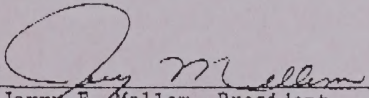
HAVRE SAND & GRAVEL
Havre, Montana
Phone 406/265-6789

This letter is written to advise you that Baltrusch Const. Co Inc hereby gives permission to the City of Havre for the storage and disposal of brush on our property North of Havre. The property is located in E $\frac{1}{2}$ of section 32, township 33, range 16, Hill County, Montana.

BALTRUSCH REPAIR CENTER
Havre, Montana
Phone 406/265-7583

BALTRUSCH LAND & CATTLE CO.
Havre, Montana
Phone 406/265-9428

Sincerely,
Baltrusch Const. Co., Inc.

By 
Jerry E. Mellem, President

APPENDIX B

HYDROGEOLOGICAL REPORT

TABLE OF CONTENTS

INTRODUCTION	1
Project and Scope	1
Location	1
Land Usage	1
Previous Investigations	2
Geological and Hydrogeological Setting	3
METHODS AND MATERIALS	3
Background Information	3
Site Investigation	3
RESULTS AND DISCUSSION	6
Site Characterization	6
Geology	6
Ground Water Occurrence	7
Ground-water Gradient	8
Ground-water Migration	8
Ground Water Quality	8
Hydrologic Budget	8
Chemical Sources and Fate	11
CONCLUSIONS	13
REFERENCES	14
APPENDICES	15
Appendix A. Maps and test boring logs from previous studies at the City of Havre sewage sludge disposal lagoon	16
Appendix B. Logs of domestic wells within one mile of the City of Havre sewage sludge lagoon	28
Appendix C. Test boring and logs for the current hydrogeological study of the City of Havre sewage sludge lagoon	34
Appendix D. A detailed report of ground water chemistry data as a sample of data from wells proximal to the City of Havre sewage sludge lagoon	39
VITA	42

Prepared by:

DAMSCHEN & ASSOCIATES, INC.

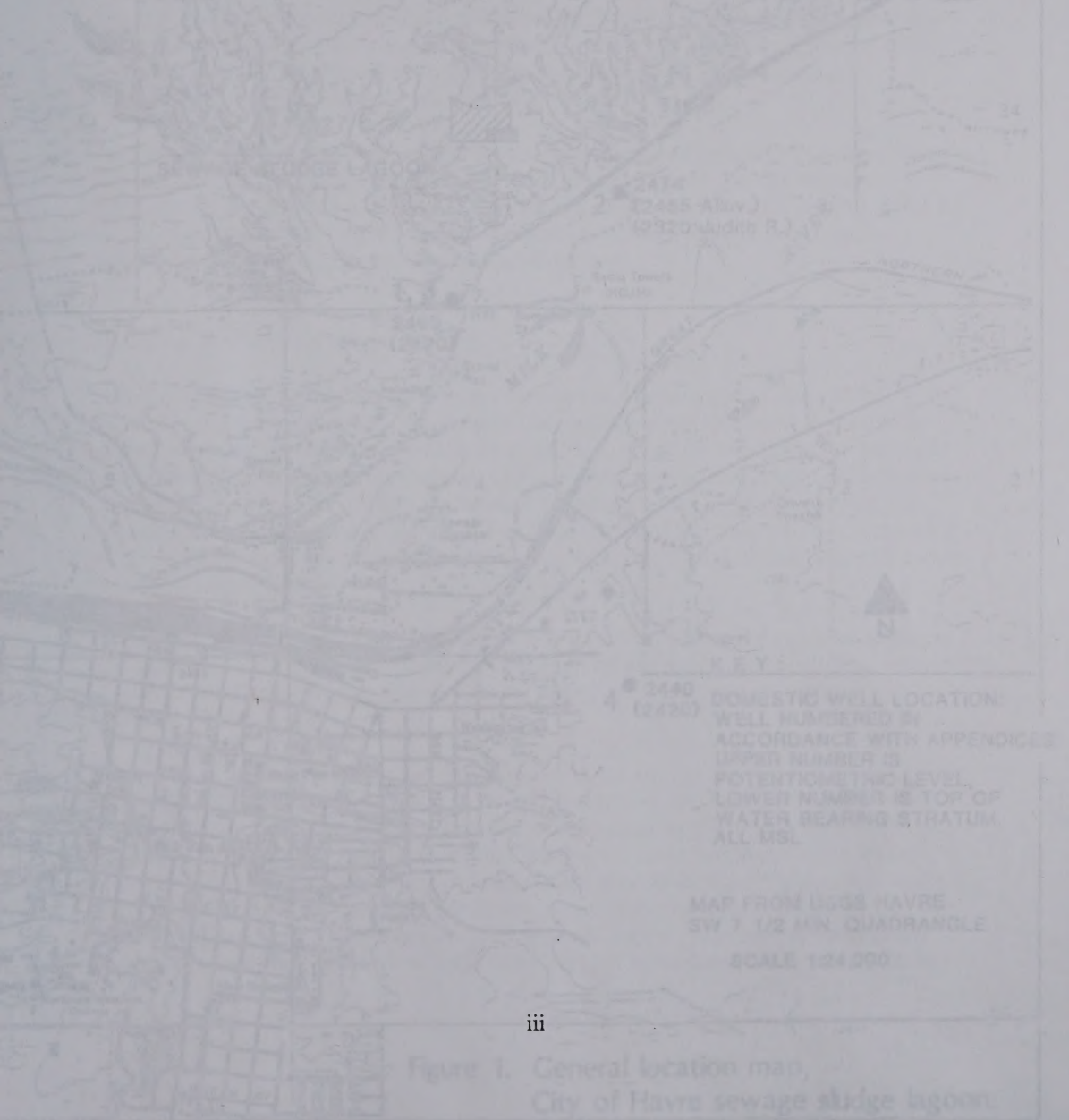
Helena, Montana

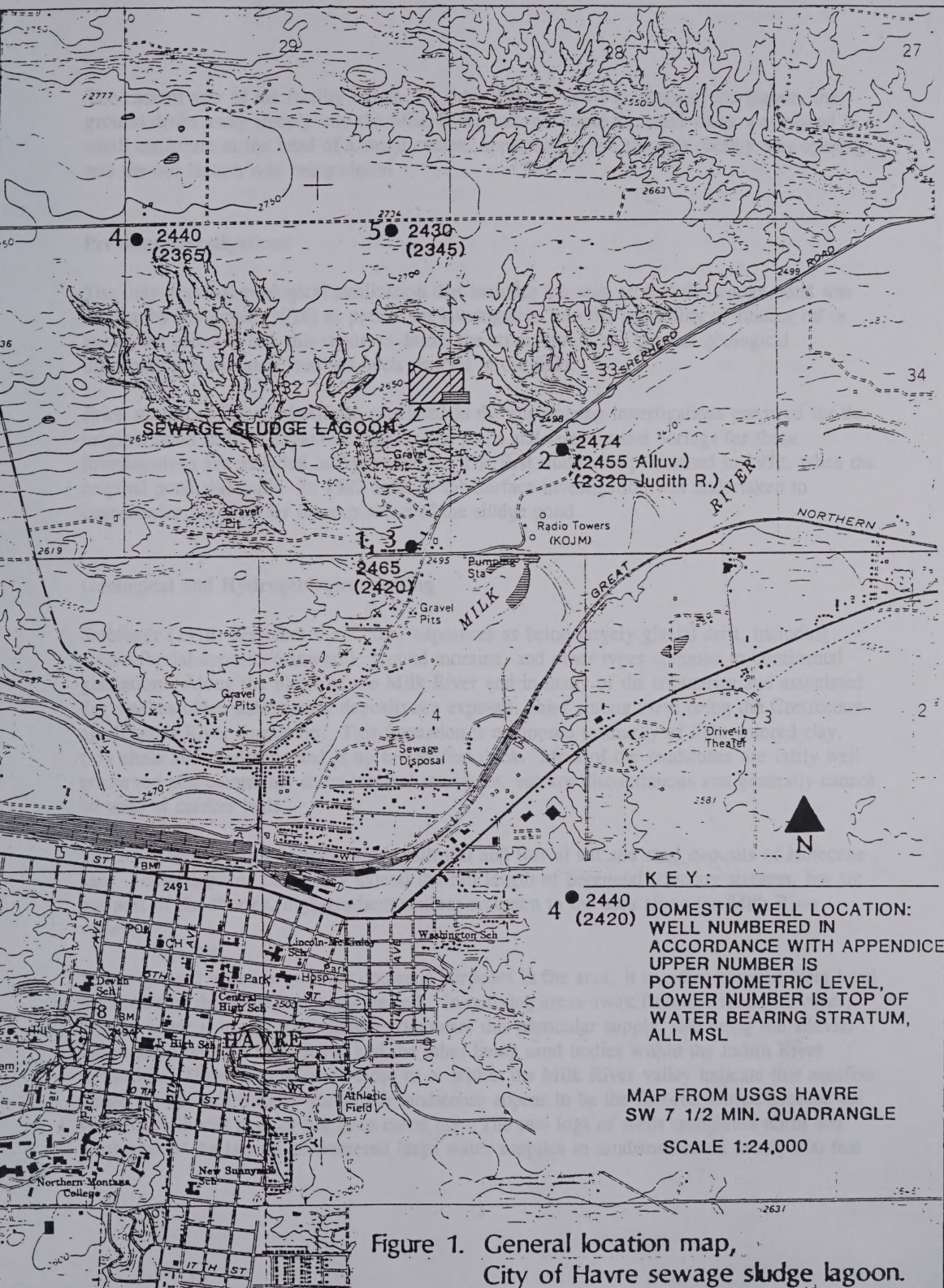
TABLE OF CONTENTS

INTRODUCTION	1
Purpose and Scope	1
Location	1
Land Usage	1
Previous Investigations	3
Geological and Hydrogeological Setting	3
METHODS AND MATERIALS	5
Background Investigation.	5
Site Investigation	5
RESULTS AND DISCUSSION	6
Site Characterization	6
Geology	6
Ground Water Occurrence	6
Ground-water Gradient	8
Ground-water Migration	8
Ground Water Quality	8
Hydrologic Budget	8
Contaminant Source and Fate	11
CONCLUSIONS	13
REFERENCES	14
APPENDICES	15
Appendix A. Maps and test boring logs from previous studies at the City of Havre sludge disposal lagoon.	16
Appendix B. Logs of domestic wells within one mile of the City of Havre sewage sludge lagoon.	28
Appendix C. Test boring and well logs of holes drilled for the current hydrogeological study of the City of Havre sewage sludge lagoon.	34
Appendix D. Analytical reports of ground-water chemistry from two samples taken from wells proximal to the City of Havre sewage sludge lagoon. . . .	39
VITA	42

LIST OF FIGURES

Figure 1. General location map of the City of Havre, Montana sewage sludge disposal lagoon.	2
Figure 2. General site location map of the City of Havre sewage sludge lagoon.	7
Figure 3. Cross section A-A', City of Havre sewage sludge lagoon.	9
Figure 4. Cross section B-B', City of Havre sewage sludge lagoon.	10





The eastern side of the facility is idle. A short distance from the edge of the lagoon, the ground drops away steeply into the Milk River valley. Some decanted water was placed in a small enclosure at the head of a small coulee, apparently while the new facility was opening and the old lagoon was being closed.

Previous Investigations

The only regional geological publication that includes the area around the sludge pond was written by Stebinger (1916) as part of an investigation into the possibility of finding oil or gas in the area. While this report is dated, the stratigraphic and general geological information is accurate, and has been verified in the field.

Prior studies of the site itself are restricted to the engineering investigations prepared for the original pond and the expansion pond. The maps and relevant test borings for these investigations are included in Appendix A. The first study was performed in 1972, when the original pond was built. In 1982 another sub-surface investigation was undertaken to characterize the area for the expansion of the sludge pond.

Geological and Hydrogeological Setting

Stebinger (1916) describes the surface exposures as being largely glacial drift, including glacio-fluvial deposits (outwash), ground moraine, and other types common to continental glaciation. Along the bluffs of the Milk River and in many of the tributaries and associated dry washes older sedimentary deposits are exposed, chief among them being the Cretaceous-aged Judith River formation. This formation is composed primarily of light-colored clay, clay shale and sandstone and is up to 480 feet thick. Most of the sandstones are fairly well preserved and commonly show internal structures, but are discontinuous and generally cannot be used as marker beds.

The Milk River valley is underlain by alluvial and fluvial silt and sand deposits of Holocene age. These deposits commonly extend the full length of perennial tributary streams, but are not part of the shorter, high-gradient coulees common to the area along the Milk River valley.

Where ground water is used for domestic purposes in the area, it is either pumped from local reservoirs or the Milk River and treated. In outlying areas away from the river, however, ground water is used. Two aquifers dominate this particular supply, one being the alluvial sediments along the Milk River and the other being sand bodies within the Judith River formation. Three logs of wells close to or within the Milk River valley indicate that aquifers deeper in the Judith River formation sandstones appear to be the favored source because the shallower alluvial aquifer has been cased off. The two logs of wells completed north and northwest of the lagoon encountered large water supplies in sandstone strata nearly 400 feet

below the ground surface. At all five of the wells closest to the site, a confined sandstone aquifer was intercepted between 2,320 and 2,365 feet above mean sea level datum (MSL). It is assumed that these water sources are related because the aquifers and potentiometric water levels are similar. It appears that the hydraulic gradient dips away from the Milk River valley, but the actual flow may be considerably different. The reason for this is that the Milk River may be a discharge zone for this relatively large sandstone aquifer. If this is the case, then the depth to which the hole is drilled will have an effect upon the apparent static water level, with a deeper hole showing a higher potentiometric surface (Fetter, 1988). This matter was not investigated further than the available data permitted. One would want to be sure that all of the holes were drilled to the same depth into the aquifer, thereby assuring consistent potentiometric levels. Such an undertaking is well beyond the scope of this investigation. It is clear from other local studies performed by the investigator that this region of the Milk River is an influent stream, supported by discharge from sandstone aquifers in the Judith River formation (Damschen & Associates, 1991a, 1991b, 1992, 1993). In the final analysis, the crucial datum is the vertical distance and lithologies that separate the sewage lagoon from the uppermost water supply point.

Site Investigation

The second phase involved a facility site investigation. This included a general examination of the geology on and around the site, the drilling test borings, the installation of monitoring wells, and the collection and analysis of ground water samples. The drilling conducted during the second phase was completed using a Gardner-Denver air rotary rig supplied by Sharp Drilling of Sidney, Montana. The monitoring wells were constructed using dog-manufactured two-inch diameter PVC flush-threaded well casing. The well screens were ten feet in length with 1/4-inch slots. The wells were completed and developed according to all relevant state regulations and guidelines. Test borings not completed as wells were plugged using a mixture of bentonite and drill cuttings.

Water samples were collected from wells after development and purging three casing volumes from each well. The samples were submitted to Energy Laboratories, Inc., in Billings, Montana, and were analyzed for nitrate as total N as well as for arsenic, chromium and nickel as total dissolved metals. The samples to be analyzed for metals were field filtered and all samples were preserved according to procedures recommended by Energy Laboratories, Inc.

METHODS AND MATERIALS

Background Investigation.

The first phase of this investigation was begun by examining all available literature and records of on-site activities. In order to determine the ground water flow in the vicinity of the sludge lagoon, logs of domestic and commercial wells were obtained from the Montana Bureau of Mines and Geology in Butte. These well logs were used to develop a general idea of the ground water depth and flow, as well as to help develop a characterization of the hydrostratigraphy of the area. These well logs are included in Appendix B of this document.

The firm that sited and engineered the facility provided the City with maps of the site and logs of three test borings drilled at the site. These documents provided stratigraphic and hydrogeological information. Copies are included herein as Appendix A.

Other miscellaneous information was provided by the Havre Wastewater Plant Supervisor and is cited within the body of this report.

Site Investigation

The second phase involved a facility site investigation. This included a general examination of the geology on and around the site, the drilling test borings, the installation of monitoring wells, and the collection and analysis of ground-water samples. The drilling conducted during the second phase was completed using a Gardner-Denver air rotary rig supplied by Sharp Drilling of Sidney, Montana. The monitoring wells were constructed using decontaminated two-inch diameter PVC flush-threaded well casing. The well screens were ten feet in length with 0.010-inch slots. The wells were completed and developed according to all relevant State regulations and guidelines. Test borings not completed as wells were plugged using a mixture of bentonite and drill cuttings.

Water samples were collected from wells after development and purging three casing volumes from each well. The samples were submitted to Energy Laboratories, Inc., in Billings, Montana, and were analyzed for nitrate as total N as well as for arsenic, chromium and nickel as total dissolved metals. The samples to be analyzed for metals were field filtered and all samples were preserved according to procedures recommended by Energy Laboratories, Inc.

RESULTS AND DISCUSSION

Site Characterization

Geology. The publication by Stebinger (1916) provides a good regional description of the study area. A brief reconnaissance of the area around the sludge lagoon provided support of the descriptions provided in that report. The steep-sided valley and coulees that border the facility are the result of erosion of very fine-grained sediments, primarily tan and greyish clay beds up to fifteen feet thick. Very good exposures of these Judith River formation deposits exist along Shepard Road and in the coulee north of the sludge lagoon. These sediments are overlain by poorly-sorted, generally coarser deposits resulting from the retreat of the continental glaciers at the end of the Pleistocene epoch. The deposits are generally poorly sorted, and particle size ranges from clay to large boulders. Good exposures of the glacial deposits occur on the access road that runs from Shepard Road, past the old race track and up to the lagoon.

Figure 2 shows the locations of test borings drilled for the construction of the ponds as well as those most recent investigation. The logs of these borings are included in Appendix C. Not all of the previously-drilled test borings could be located. Apparently four more borings were drilled at the site, but the location sketch referred to on the logs could not be retrieved from the drilling or engineering firms that performed the site study in 1972. Nonetheless, with all of the studies performed to date, it is considered that the sub-surface coverage is fairly good.

Ground Water Occurrence. Generally speaking, ground water occurs beneath the site in two distinct elevations. Shallow ground water occurs within the glacial deposits, which lie atop the Judith River formation to a depth of about 30 feet. While deeper ground water was not pursued at the site, two well logs within a mile north of the facility indicate that ground water of economic value occurs at depths approaching 400 feet below the ground surface (Appendix B). A short distance to the south, well logs from an area at the elevation of the flood plain of the Milk River show that a deeper aquifer was also tapped in this area. It appears that the alluvial aquifer associated with the Milk River has not been a target for economic withdrawal of water in the area.

The test boring and monitoring well logs show that the shallow ground water occurrence is inconsistent at the site (Appendix A, B). It appears that one or more sand bodies within the mantle of glacial drift act as aquifers perched atop low-permeability strata. These relatively impermeable strata appear to lie within the glacial material, although the clay beds of the Judith River formation may also act as an aquitard; it appears from the information gathered at HSL-1 that the Judith River formation lies within about 30 feet of the surface.

Shallow ground water was discovered at MW-1, MW-2 and, previously, at DH-1 and DH-2. These holes lie roughly on an east-west line across the northern edge of the lagoon (Figure 2). The logs do not reveal enough consistency in lithologies to say with confidence that the

sand bodies encountered in the borings are in communication with one another, although they probably do to some degree. The sand bodies that contain water here probably represent relatively well-sorted glacio-fluvial deposits within a larger body of ground moraine and other massive drift deposits.

Ground-water Gradient. The direction of ground-water flow appears to be to the northeast, however the confidence level of this is in some question (Figures 3 and 4). Monitoring wells MW-1 and MW-2 show a difference in water table, or potentiometric surface of over six feet across a relatively short distance of 340 feet. This is a gradient of 0.02, which is fairly steep for these relatively permeable sand bodies.

It is interesting that, while the static water levels are somewhat lower than the most recently-installed wells, the test borings DH-1 and DH-2 also show a fairly steep westerly gradient. This would point toward the ground-water gradient generally reflecting the ground surface.

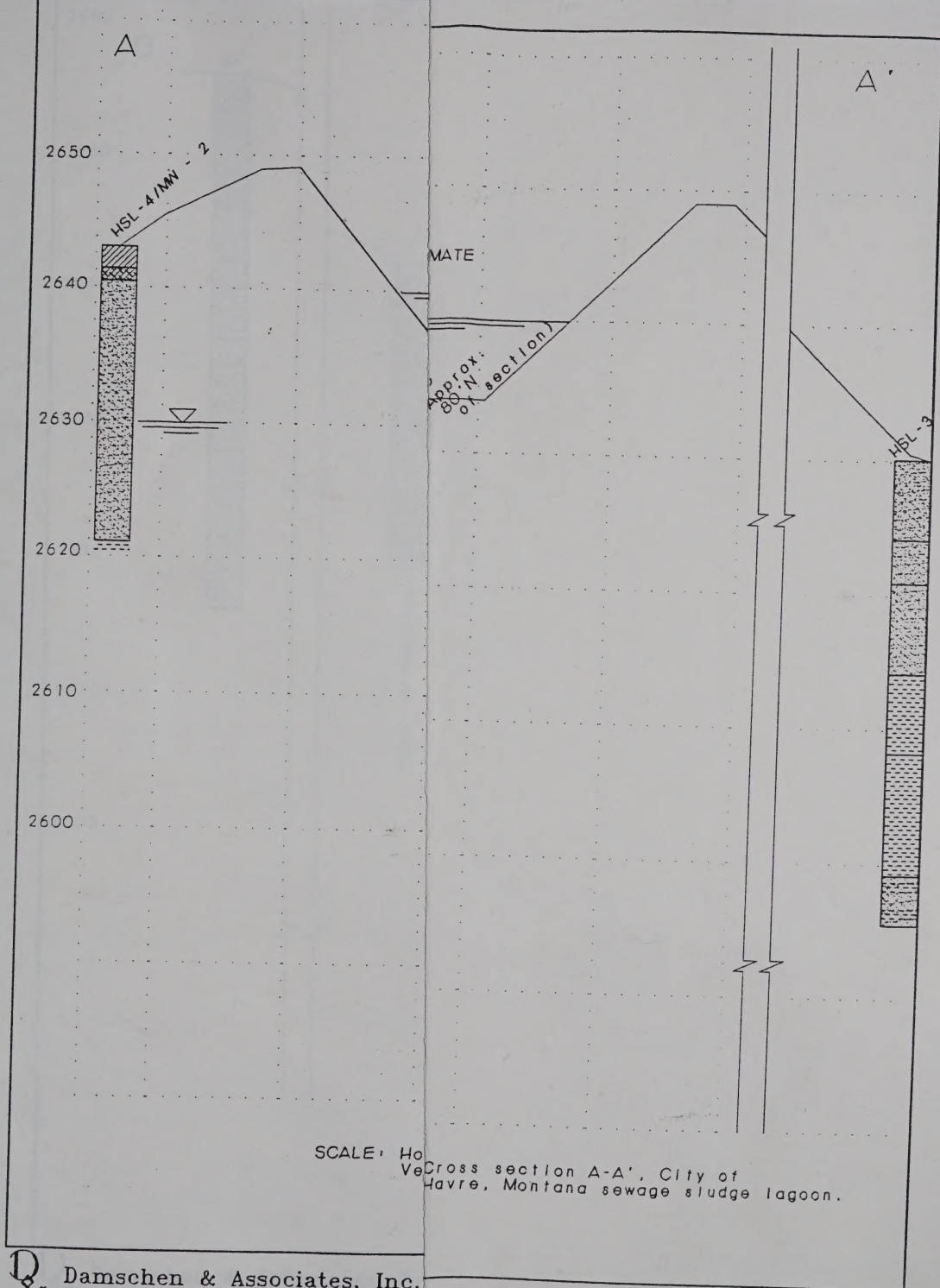
Ground-water Migration. The final fate of the shallow ground water at the lagoon site is not entirely clear. However, several lines of evidence lead to the conclusion that if the ground water is migrating at all, it is doing so at a very slow rate.

Ground water does not occur everywhere throughout the site. It appears to be confined to sand bodies beneath the northern half of the facility. There does not appear to be significant lateral migration, because at several points along the northern side of the site, the sand bodies lie within a few tens of feet of a very steep-walled valley in which no springs, seeps or excessively lush vegetation occurs. Also, the logs of test borings to the south (HSL-3, DH-3, -16, Appendices A and B) show the existence of dry sand bodies proximal to and below the static water level of perched aquifers.

If significant vertical migration were occurring, the aquifer would have to have a significant source of recharge in order to maintain the relatively steep gradient. The sludge pond certainly holds the potential for such recharge, yet the water level within the pond changes most visibly with the seasons. That is, the level tends to drop during months of high evaporation, and rise during periods of low evaporation (K. Kline, personal communication).

Ground Water Quality. The results of the ground-water analyses show that high levels of nitrate occur in the ground water proximal to the lagoon (Appendix D). Water from MW-1 and MW-2 had 480.0 and 39.4 milligrams per liter (mg/l) nitrate as N, respectively. Chromium and nickel were found in MW-1 and MW-2, respectively, at the lower detection limit. The nitrate levels exceed the accepted maximum contaminant level (MCL) of 10 mg/l.

Hydrologic Budget. According to the Havre wastewater plant supervisor, the lagoon receives an average of 2,225 cubic feet of sludge per day. The surface area of the pond is slightly less than 9 acres, depending upon the water level. This translates to about 411,000 square feet of water surface. The area receives an average of 11.17 inches of

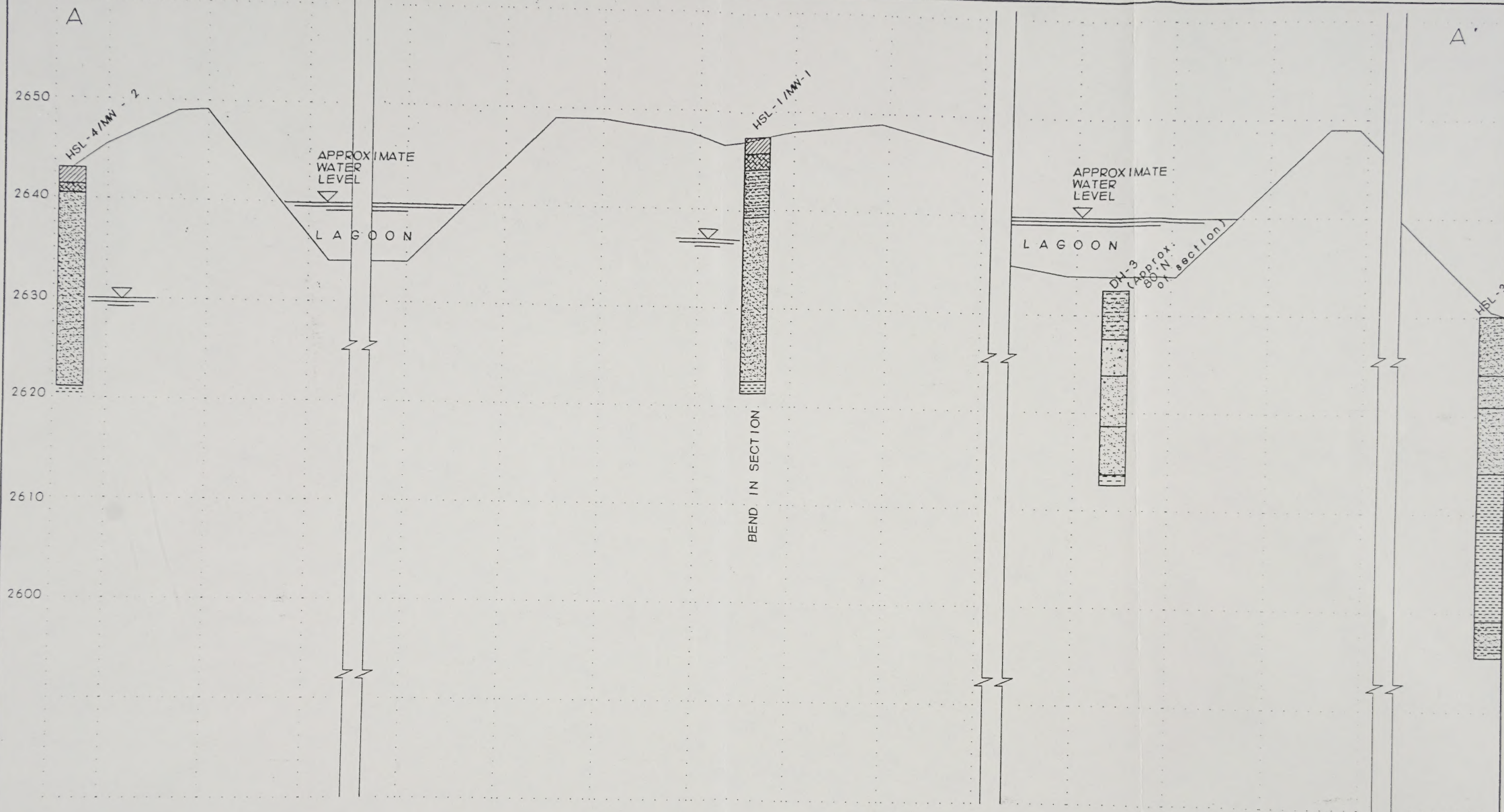


SCALE: Ho
 Ve Cross section A-A', City of
 Havre, Montana sewage sludge lagoon.



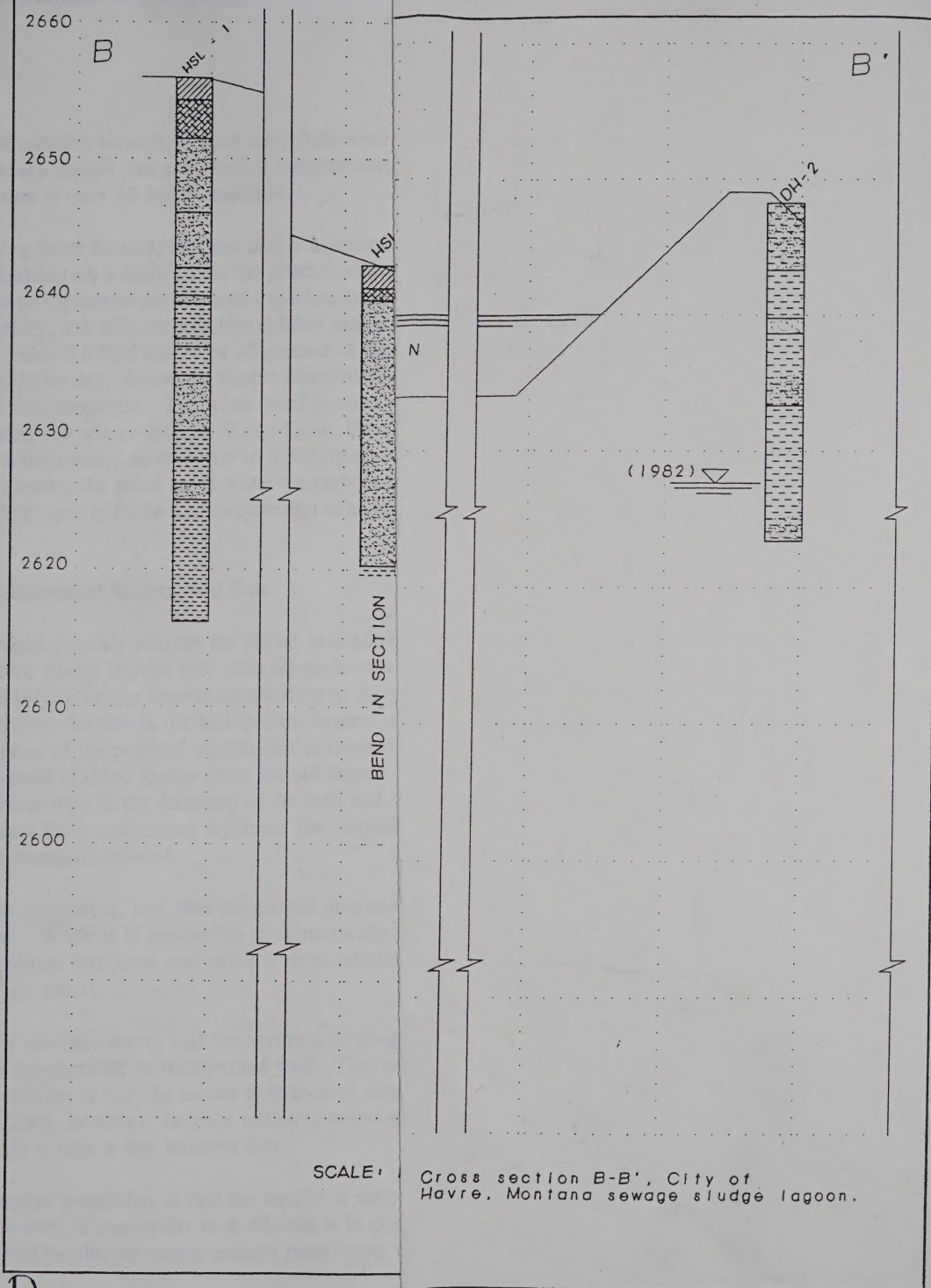
Damschen & Associates, Inc.

CONSULTING ENGINEERS
 •2030 11th Ave., Suite 11•
 •HELENA, MONTANA•



SCALE: Horiz. 1"=40'
Vert. 1"=10'

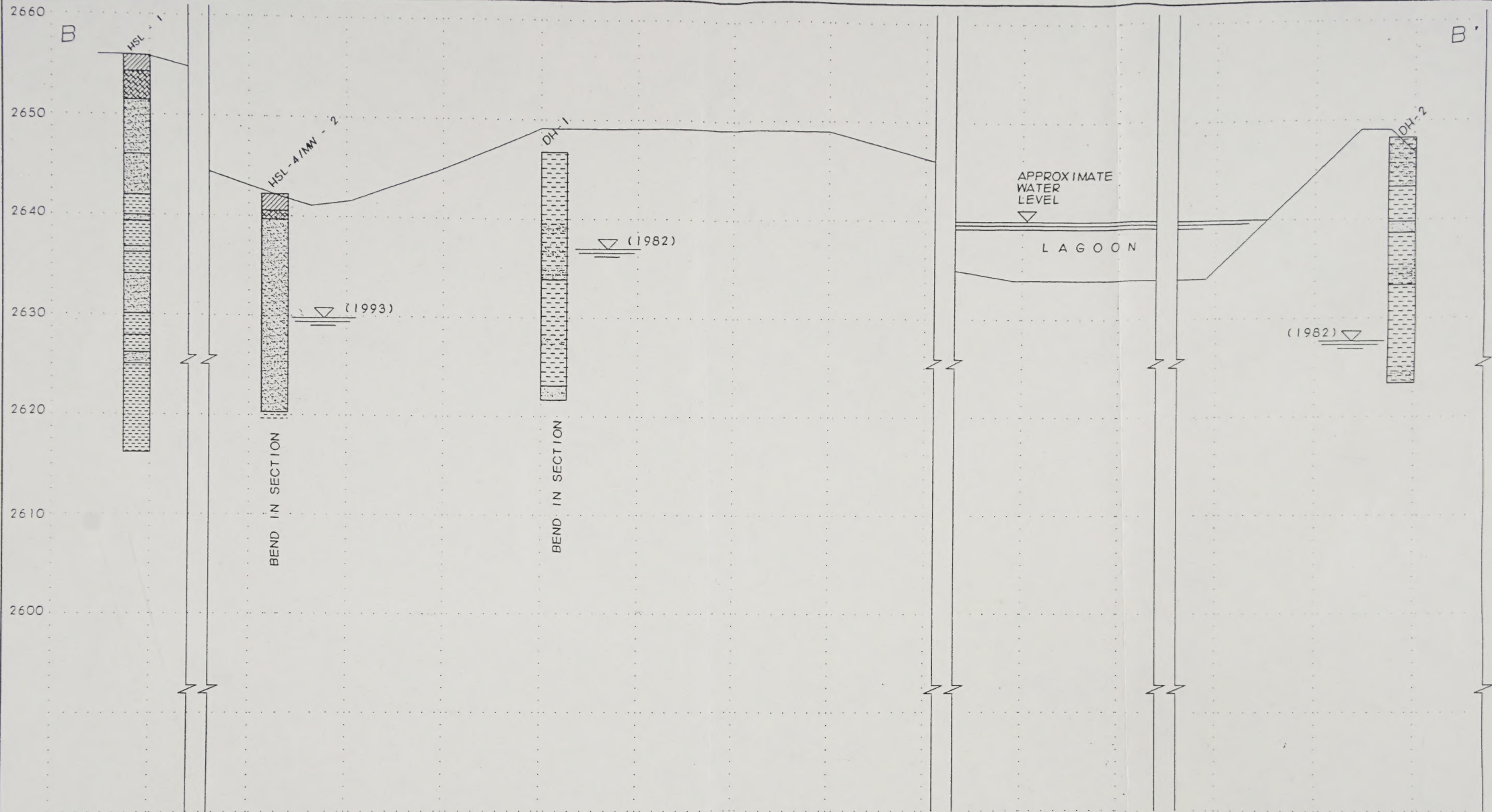
Figure 3. Cross section A-A', City of Havre, Montana sewage sludge lagoon.



Damschen & Associates, Inc.

CONSULTING ENGINEERS

•2030 11th Ave., Suite 11•
•HELENA, MONTANA•



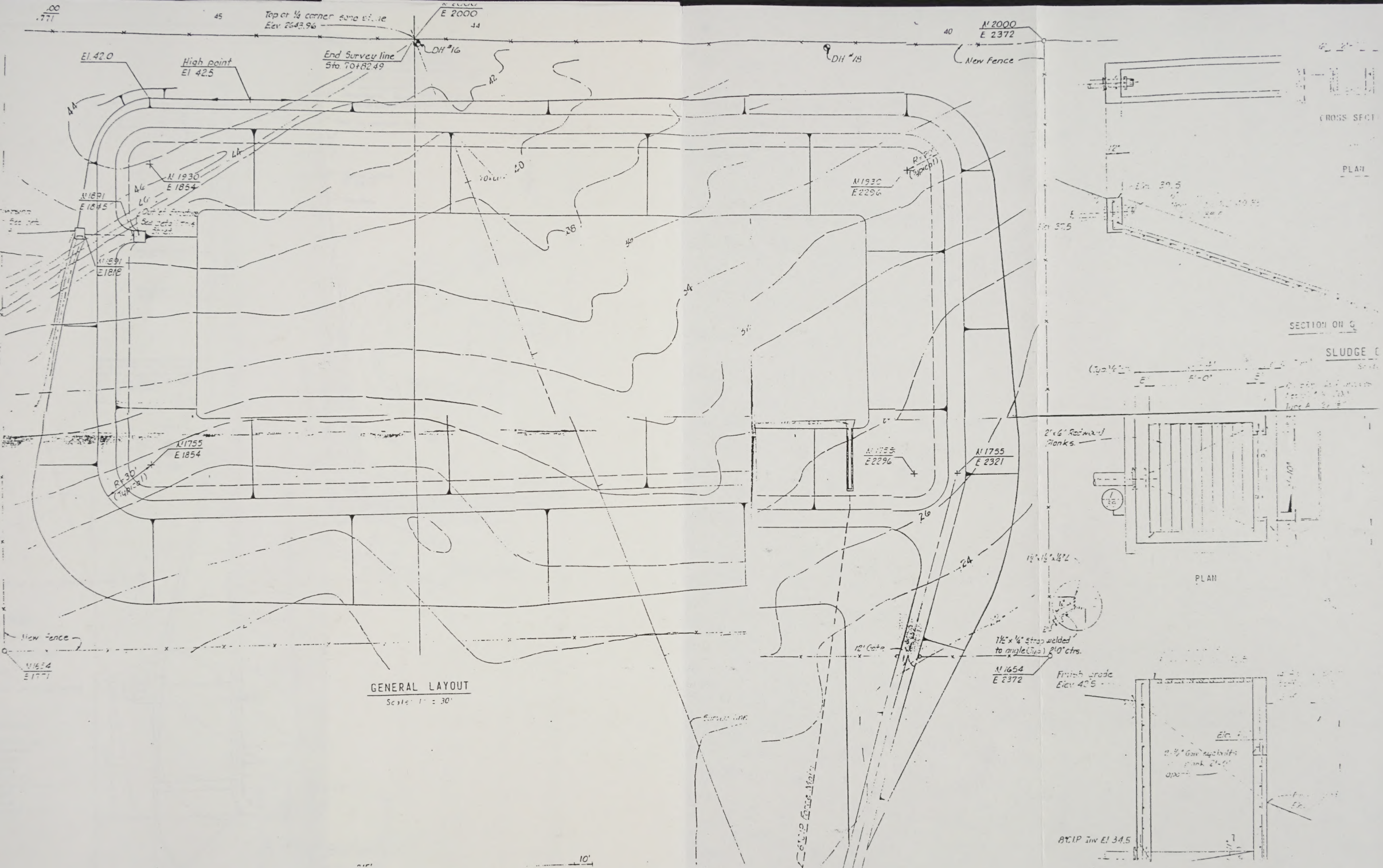
SCALE: Horiz. 1"=40'
Vert. 1"=10'

Figure 4. Cross section B-B', City of Havre, Montana sewage sludge lagoon.



Damschen & Associates, Inc.

CONSULTING ENGINEERS
•2030 11th Ave., Suite 11•
•HELENA, MONTANA•



precipitation annually, based upon data reported at the Havre airport west of town. The average annual pan evaporation rate calculated at the Fort Assiniboine agricultural research station is over 32 inches annually.

Using these figures, one can derive a general estimate of the hydrologic budget. If calculated on a daily basis, the pond receives a daily average of 0.00795 inches of effluent and precipitation per day and experiences an evaporation rate of 0.088 inches per day. Notably, the effluent provides 0.0054 inches, or 68 percent of the volume and precipitation provides 0.00255 inches or 32 percent of the average daily input. On this basis, the pond should be dry; however, simple observation and common sense indicate that the system is not this simplistic. The water level is observed to drop during the summer months and rise during the winter months (Kristi Kline, Havre wastewater plant supervisor, personal communication) in response to differing seasonal precipitation and evaporation regimes. In any event, the pond holds water throughout the year and was clearly designed manage the inflow, precipitation and evaporation conditions that exist at the site.

Contaminant Source and Fate

Several possible sources for nitrate in shallow ground water exist on and proximal to the Havre sludge lagoon site. The most obvious source is the lagoon itself. However, it is unlikely to be the source contributing to the ground water contamination. The most obvious evidence for this is the fact that the highest nitrate level in the ground water comes from a portion of the perched aquifer that is immediately overlain by the ground used for surface disposal of dried sludge from the old lagoon. This, combined with the facts that the land surface dips in the direction of the well and the depth to ground water is less than 11 feet makes for a compelling argument for vertical migration of contaminants from the surface as the dominant process.

It is interesting, too, that the ground proximal to the facility is being utilized as agricultural land. While it is impossible to delineate the potential sources chemically, surface infiltration of nitrate fertilizers and cattle-derived nitrates into shallow ground water must be considered at this site.

It is also interesting that the apparent down-gradient well contains lower nitrate levels than the up-gradient, or background well. This can be interpreted in several ways. One possibility is that the nitrate is attenuated somehow between MW-1 and MW-2. This seems unlikely, however, because nitrate is notoriously persistent and the distance between the two wells is only a few hundred feet.

Another possibility is that the aquifer is diluted by infiltration of relatively fresh water. However, a source for such dilution is in question: it is unlikely that the sludge lagoon would be able to supply enough fresh water for a 10-times dilution of nitrate. Considering

the inflow rate, evaporation rate and precipitation rate, it would seem more likely that the down-gradient well would be enriched in nitrate under such a scenario.

A third possibility, and one that seems to accommodate all of the peculiarities observed, is that the water in the perched aquifers is recharged seasonally, and most of the outflow occurs through upwards migration as a result of capillary and evapotranspiration processes. Even with some downward migration, this would create a scenario in which there is relatively little exchange of moisture, resulting in an ever-increasing concentration of contaminants in the uppermost aquifer. Assuming that there is some very slow rate of lateral migration toward MW-2, one would expect there to be an elevated level of contaminants tempered by surface infiltration.

The most obvious problem with all of these scenarios is that the elevation changes in the water surface of the pond do not range in a manner that would indicate the loss of any moisture to the underlying strata. The hydrologic budget is such that evaporation should come close to drying the pond completely, when in fact the surface level changes very little.

Another problem with any hypothesis demanding the downward migration of moisture from the pond is the nature of the bottom of the pond. The base of the lagoon apparently consists of soils re-compacted *in-situ* along with soils moved from within the site. In the past twelve years, sludge solids have been accumulating at the bottom of the pond, presumably to a point that a significant thickness of solids and organic material now exist. It seems logical to assume that these sediments would retard downward fluid migration.

The nitrate levels in the new surface ground water exceed the accepted MCL. The source of the nitrate found in monitoring well MW-1, which is the up-gradient well, is a result of the spreading of dried sludge on sandy soil that overlies the top of the water table by only 11 feet; the lower nitrate level observed in simply from MW-2, the down-gradient well, is probably a result of runoff and surface infiltration from both the sludge application area and the adjoining agricultural land. This distribution of nitrate content also supports the idea that these sand bodies are isolated perched aquifers because concentrations are increasing more concentrated with time. There is also a higher nitrate concentration in the pond directly adjacent with dried sludge (MW-1) than with an area that receives a small amount of runoff from the sludge-covered area.

In summary, while there is need evidence for nitrate accumulation in near-surface sand bodies, there is also good evidence that the source of the nitrate is related to weathering of the local application of sludge at the surface and, possibly, agricultural activities adjacent to the site. Therefore, it can be concluded that the quality of the ground water that is used for domestic and commercial purposes in the area are not as compromised by the presence of the sewage sludge lagoon.

CONCLUSIONS

Based upon the information provided by City of Havre personnel, test borings performed on three separate occasions, climatic data and empirical observation, it is concluded that the City of Havre poses no threat to the ground-water supply in the area. This is based upon the following observations:

- The ground water being used for human consumption is separated from the lagoon by well over 300 feet of fine-grained sediment dominated by clay, clay shale and relatively discontinuous sandstone bodies;
- Hydrologic budget calculations do not support the concept of ground water is being lost through the bottom of the lagoon;
- Based upon the relatively steep hydraulic gradient and high hydraulic conductivity of the saturated sand bodies, an ample supply and release of water should be taking place, yet no recharge source can be documented and no surface outlet can be seen; this leads to the conclusion that the saturated zones are isolated, virtually unconnected sand bodies that experience very little turnover of moisture;
- The sand bodies cannot be acquiring water from the sludge pond for several reasons: primarily it seems unlikely that a point down gradient from infiltration by sewage sludge water could have nitrate levels that are diluted by a factor of 10, particularly when nitrate levels in the sludge range from 1,000 milligrams per kilograms (mg/kg) to over 5,500 mg/kg;
- The nitrate levels in the near-surface ground water exceed the accepted MCL; the source of the nitrate found in monitoring well MW-1, which is the up-gradient well, is a result of the spreading of dried sludge on sandy soil that overlies the top of the water table by only slightly more than 11 feet; the lower nitrate level observed in sample from MW-2, the down-gradient well, is probably a result of runoff and surface infiltration from both the sludge-application area and the adjoining agricultural land; this distribution of nitrate content also supports the idea that these sand bodies are isolated perched aquifers because contaminants are becoming more concentrated with time; there is also a higher nitrate concentration in the area directly covered with dried sludge (MW-1) than with an area that receives a small amount of runoff from the sludge-covered area.

In summary, while there is good evidence for nitrate accumulation in near-surface perched aquifers, there is also good evidence that the source of the nitrates is a direct or secondary result of the local application of sludge at the surface and, possibly, agricultural activity proximal to the site. Therefore, it can be concluded that the quality of the ground water that is used for domestic and commercial purposes in the area are in no way threatened by the presence of the sewage sludge lagoon.

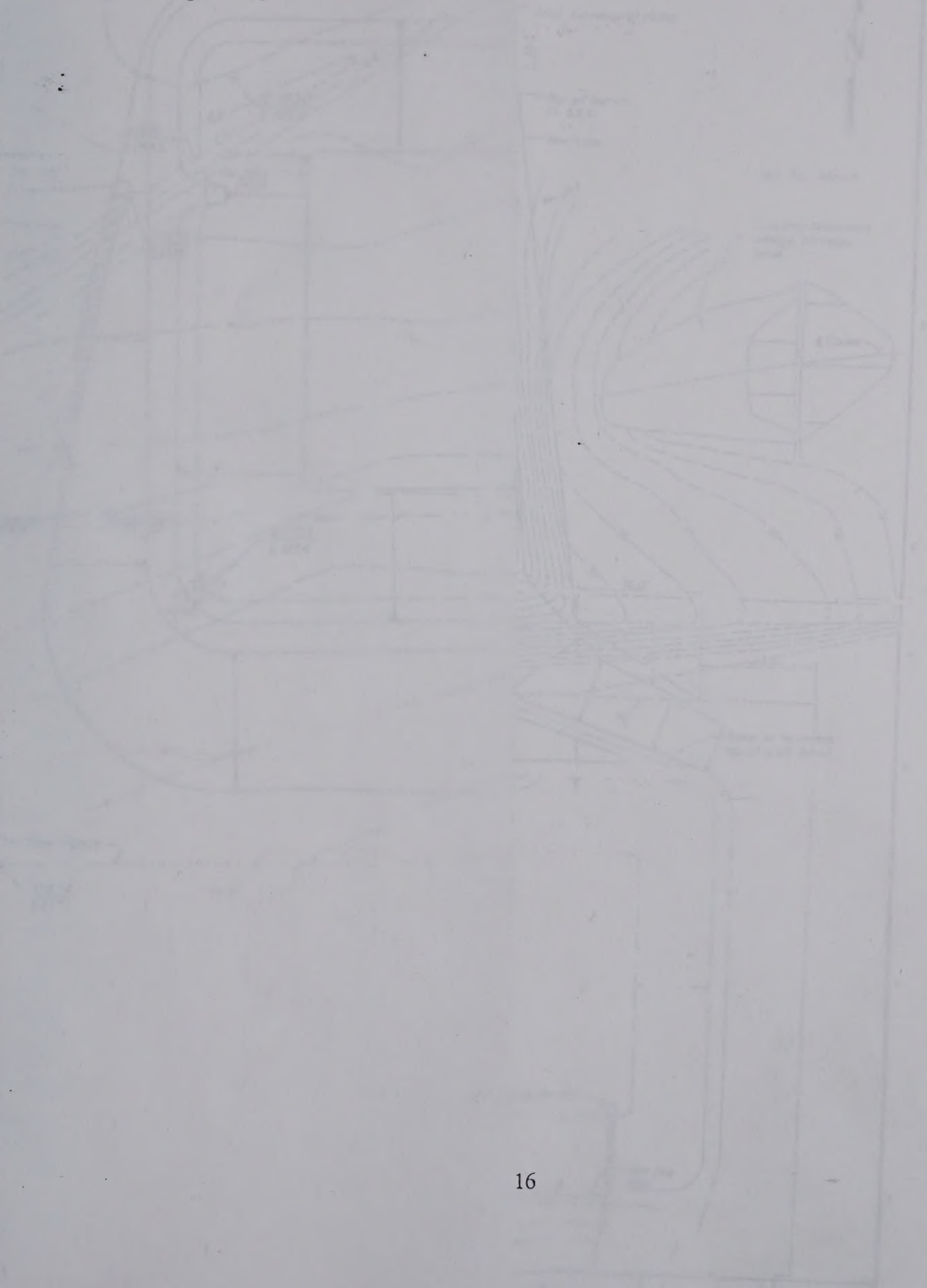
REFERENCES

- Damschen & Associates, Inc., 1991a, Additional hydrogeologic investigations for proposed Malta landfill: Unpublished report submitted to the City of Malta, Montana, May, 1991, 27 pages.
- Damschen & Associates, Inc., 1991b, Hydrogeologic analysis for the existing sanitary landfill: Unpublished report submitted to the Unified Disposal District, Havre, Montana, October, 1991, 105 pages.
- Damschen & Associates, Inc., 1992, Operation plan and license application, City of Malta Class II sanitary landfill, Appendix B, hydrogeological and soils investigation: Landfill license application submittal to the Montana Solid and Hazardous Waste Bureau on behalf of the City of Malta, Montana, 136 pages.
- Damschen & Associates, Inc., 1993, Additional hydrogeologic and soils analysis of the Unified Disposal District landfill, Havre, Montana: Unpublished report submitted to Montana Solid and Hazardous Waste Bureau, Helena, Montana, October, 1993, 150 pages, 1 plate.
- Fetter, C.W., 1988, Applied hydrogeology, second edition: Merrill Publishing Company, Columbus, Ohio, 592 pages.
- National Oceanic and Atmospheric Administration (NOAA), 1990, Climatological data annual summary, Montana, 1990: National Oceanic and Atmospheric Administration, volume 93, number 13, 44 pages.
- Stebinger, E., 1916, Possibilities of oil and gas in north-central Montana: United States Geological Survey Bulletin 641-C, 22 pages, 1 plate.

APPENDICES

Appendix A. High and low tides at the City of Havana during
August 1960.

Appendix A. Maps and test boring logs from previous studies at the City of Havre sludge disposal lagoon.

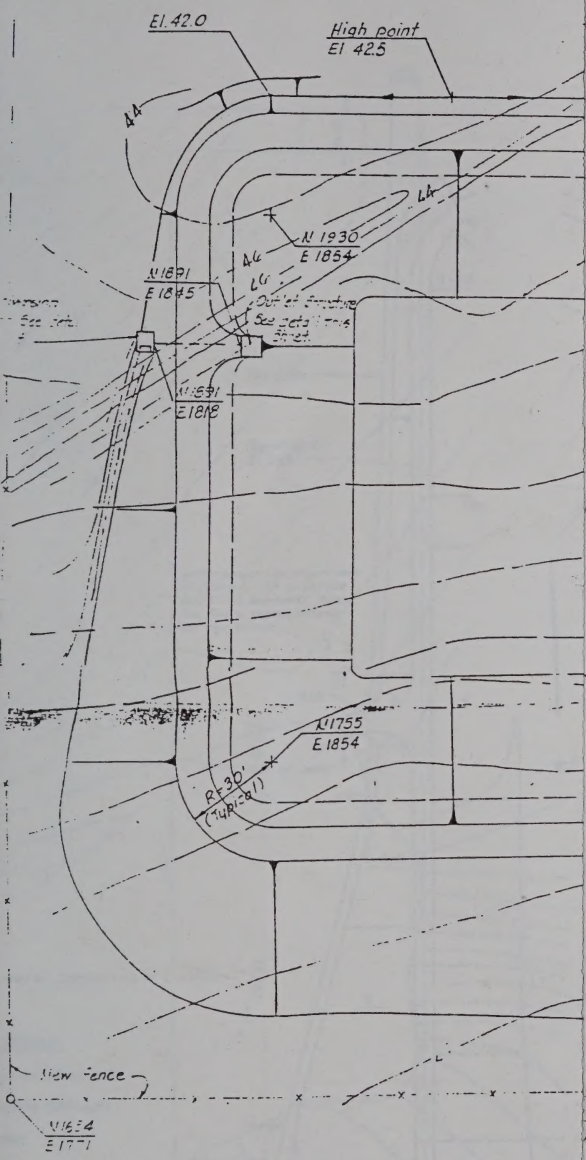


100
.771

45

Top of 1/4 corner
Elev. 2643.96

10



Note:

1. To obtain elevations in U.S.S. datum, add 2600 to the figures shown.
2. New items of work designated as heavier weight lines, all lighter weight lines are existing construction
3. Benchmark: Top of N.W. corner of existing outlet structure, El. 43.5.

Exist. turnaround ramp

28.5'

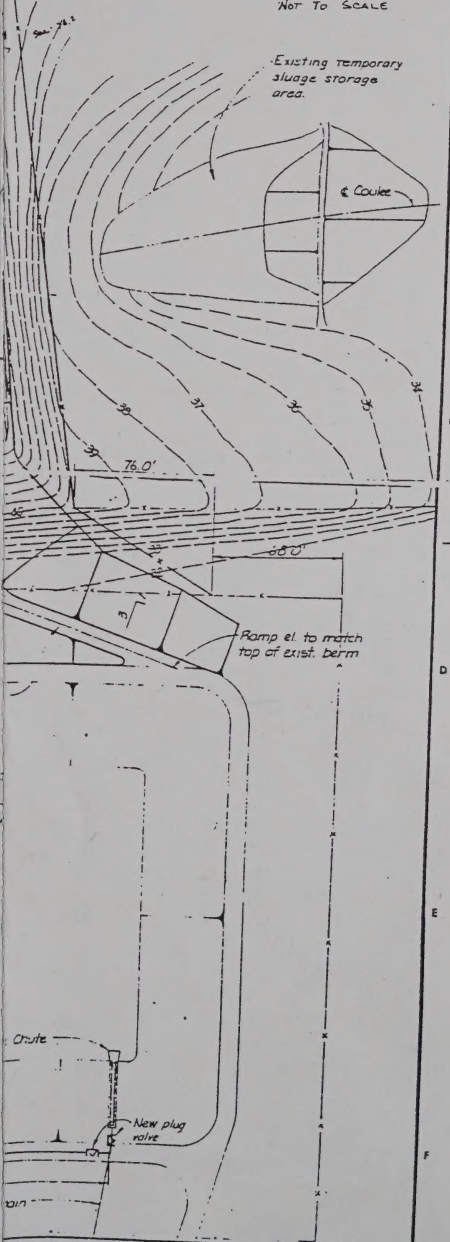
Top of berm
El. 53.5

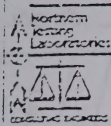
New fence

NOT TO SCALE

Existing temporary
sludge storage
area.

Coulee





PROJECT: Havre Wastewater Treatment

Facility - Lagoon

JOB NO.: 82-212

HOLE NO. DH 1

SHEET 1 OF 2

LOCATION 10' S of hub with lath locat

150' ± E of NW lagoon corner

DRILL TYPE: SOIL Mobile B-50, with 2" hollowstem auger

ROCK

ELEVATION: TOP OF HOLE 99.8

11.0' GROUNDWATER 88.8

DRILLED BY: W. Neff

LOGGED BY: G. Quinn

DATE: HOLE STARTED 12/18/82

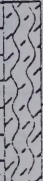
REMARKS: Reference elevation: assumed 100.0 at
top of hub with lath located 150' ± E of
NW lagoon corner.

HOLE COMPLETED 12/18/82

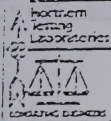
DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	S.P.T. (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	IN-PLACE DENSITY (pcf)	L.L. %	P.I. %	GRAVEL %	SAND %	SILT %	CLAY %
0		CLAY, Silty; firm to very stiff, moist to saturated, brown, little sand, few fine gravels (CL)										
		becoming more sandy, containing numerous sand seams with depth.										
5			SSS	7	16							
		split spoon wet										
10			SSS	18	16							
11.0		GWL (12/18/82)										
13.5		CLAY, Silty; Glacial Till; very stiff to hard, moist to saturated, brown, some sand, little gravel, some carbon detritus (CL).	SSS	26	28							
20		wet sand layer at 19.7'.	SSS	40	19							

continued...

NTL 150

DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	SPT (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	IN-PLACE DRY DENSITY (pcf)	LL %	PI %	GRAVEL %	SAND %	SILT %	CLAY %
20		CLAY, Silty; Glacial Till; very stiff to hard, moist to saturated, brown, some sand, little gravel, some carbon detritus (CL).										
23.5		SAND, Poorly Graded; medium dense, saturated, brown, sand is fine to medium (SP).	SSS	23	17							
25.0		BOTTOM OF HOLE										

LOG OF EXPLORATION HOLE



PROJECT: Havre Wastewater Treatment
Facility - Lagoon

JOB NO.: 82-212

DRILL TYPE: SOIL Mobile B-50, with 8" hollowstem auger
ROCK

DRILLED BY: W. Neff

LOGGED BY: G. Quinn

REMARKS: Reference elevation: assumed 100.0 at
top of hub with lath located 150'± E of
NW lagoon corner.

HOLE NO. DH 2

SHEET 1 OF 2

LOCATION 100' S of hub at NE lagoon
corner

ELEVATION: TOP OF HOLE 99.5

21.3' GROUNDWATER 78.2

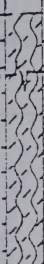
DATE: HOLE STARTED 12/18/82

HOLE COMPLETED 12/18/82

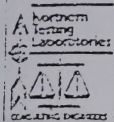
DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	S.P.T. (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	N. PLACE DENSITY (pcf)	L.L. %	P.I. %	GRAVEL %	SAND %	SILT %	CLAY %
0		FILL; CLAY, Sandy; stiff, moist, brown, little gravel.										
5.0		CLAY, Sandy; stiff, moist, brown, little gravel (CL).	SSS	14	13							
8.5		SAND, Silty; loose, very moist to wet, brown, few roots (SM).										
9.2		CLAY, Sandy; Glacial Till; stiff to very stiff, moist to slightly moist, brown, few gravels, some carbon detritus (CL).	SSS	8	18							
15.0		numerous sand layers, some silty clay layers near 14.5'	SSS	30	12							
		CLAY, Silty; Glacial Till; very stiff, moist to saturated, brown, little sand, few gravels, some carbon detritus (CL).										
20			SSS	22	15							

continued...

NTL 150

DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	SPT (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	IN-PLACE DRY DENSITY (pcf)	LL %	PI %	GRAVEL %	SAND %	SILT %	CLAY %
20												
21.3		GWL (12/18/82) CLAY, Silty; Glacial Till; very stiff, moist to saturated, brown, little sand, few gravels, some carbon detritus (CL).										
		more sandy; split spoon wet	SSS	22	17							
25.6		BOTTOM OF HOLE										

LOG OF EXPLORATION HOLE



PROJECT: Havre Wastewater Treatment Facility - Lagoon

JOE NO.: 82-212

DRILL TYPE: SOIL Mobile R-50 with 2" hollowstem auger
ROCK _____

DRILLED BY: W. Neff

LOGGED BY: G. Quinn

REMARKS: Reference elevation: assumed 100.0 at top of hub with lath located 150'± E of NW lagoon corner.

HOLE NO. DH 3

SHEET 1 OF 1

LOCATION 230' S of SW lagoon corner

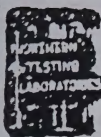
ELEVATION: TOP OF HOLE 82.2

GROUNDWATER None

DATE: HOLE STARTED 12/18/82

HOLE COMPLETED 12/18/82

DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	S.P.T. (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	IN-PLACE DENSITY (pcf)	L.L. %	P.I. %	GRAVEL %	SAND %	SILT %	CLAY %
0		CLAY, Sandy; Glacial Till; very stiff to hard, moist, brown, some sand seams and lenses, some carbon detritus (CL).										
4.8		SAND, Gravelly; dense to very dense, moist, brown, trace clay (SW-SC). sand more coarse, with some clay fines	SSS	34	14							
9.2		SAND, Clayey; dense to very dense, moist, brown, little gravel, sand is coarse, some carbon detritus (SC).	SSS	62	11							
13.5		SAND, Silty; dense, very moist to wet, brown, few carbonaceous seams (SM). sand is wet at 19.0'; some clay seams	SSS	40	18							
19.0		CLAY, Silty; Glacial Till; hard, moist, gray, little gravel, few sand	SSS	43	17							
20.0		BOTTOM OF HOLE & silt lenses, little carbon detritus. (CL)										



GREAT FALLS MISSOURI • BILLINGS MONTANA • BOISE IDAHO

LOG OF EXPLORATION BORING

MOLE NO. 1011 No. 18

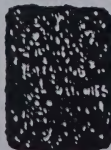
JOB NO. 72-24

SHEET 1 OF 2

DRILL TYPE Mobile B-51	PROJECT WASTE WATER TREATMENT PLANT
SIZE, TYPE OF HOLE 7-1/2 Inch Diameter: Hollow Auger	UNIT Pipe Line Alignment
CASING SIZE None	LOCATION Lagoon 250' East of Station 70 + 80
TOTAL NO. OF OBSERVATIONS 9	NAME OF DRILLER H. Coyne
Drilled 9	ELEVATION TOP OF HOLE 2639.4
TOTAL NO. CORE BOXES 0	GROUNDWATER None
REMARKS	THICKNESS OF OVERBURDEN 41.6'
	DEPTH DRILLED INTO ROCK 0
	TOTAL DEPTH OF HOLE 41.6'
	DATE MOLE Started 4-05-72 Completed 4-05-72
	SIGNATURE OF INSPECTOR H. Knutson

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIAL	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
0.4			TOPSOIL, organic matter			Moisture Content, %
5			SAND, Silty; dry to damp, loose to medium loose, some clayey lenses, scattered gravel		SPT	2.1 - 3.6 : 5/8/8 4
11.5					SPT	7.6 - 9.1 : 4/7/7 13
15			CLAY, Silty; considerable sand, dry, medium firm		SPT	12.6 - 14.1 : 6/6/16 3
16.1					SPT	17.6 - 19.1 : 9/23/34 14
20			SAND, Silty; compact to very compact, damp, some clayey fines		SPT	22.6 - 24.1 : 16/32/40 12
25					SPT	27.6 - 29.1 : 11/22/30 4
30						

NPL 122



GREAT FALLS MISSOURI • BILLINGS MONTANA • BOISE IDAHO

LOG OF EXPLORATION BORING

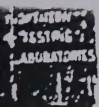
MOLE NO. 1011 No. 1A

JOB NO. 72-24

SHEET 1 OF 1

PROJECT

WASTEWATER TREATMENT PLANT

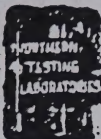


LOG OF EXPLORATION BORING

HOLE NO. DH No. 18JOB NO. 72-26SHEET 2 OF 2

DRILL TYPE: SOIL <u>Mobile 2-32</u> ROCK		PROJECT <u>WASTE WATER TREATMENT PLANT</u>	
SIZE, TYPE OF BIT <u>7-1/2 inch Diameter Hollow Auger</u>		UNIT <u>Pipe Line Alignment</u>	
CASING SIZE <u>None</u> LENGTH		LOCATION <u>Lagoon 250' East of Station 70 + 80</u>	
TOTAL NO OF OVERBURDEN SAMPLES TAKEN		NAME OF DRILLER <u>M. Couture</u>	
Disturbed <u>9</u>	Undisturbed <u>0</u>	ELEVATION, TOP OF HOLE <u>2639.4</u> GROUNDWATER <u>None</u>	
TOTAL NO CORE BOXES <u>0</u>	TOTAL CORE RECOVERY FOR BORING (%)	THICKNESS OF OVERBURDEN <u>41.6'</u>	DEPTH DRILLED INTO ROCK <u>0</u> TOTAL DEPTH OF HOLE <u>41.6'</u>
REMARKS		DATE HOLE Started <u>4-05-72</u> Completed <u>4-05-72</u>	
		SIGNATURE OF INSPECTOR <u>M. Knutson</u>	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	% COREBOX OR RECOV. SAMPLE		REMARKS (Drilling time, water level, depth of weathering, etc., if significant)	Moisture Content, %
				ERY	NO		
30			SAND, Silty; medium compact, damp				
32.6					SPT	32.6 - 34.1 : 9/18/19	15
35			CLAY, Silty; medium firm, damp to moist, glacial till, some scattered gravel				
					SPT	37.6 - 39.1 : 5/11/18	16
					SPT	39.1 - 41.6 : 7/11/22	20
41.6							



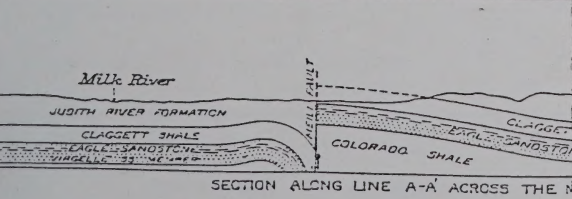
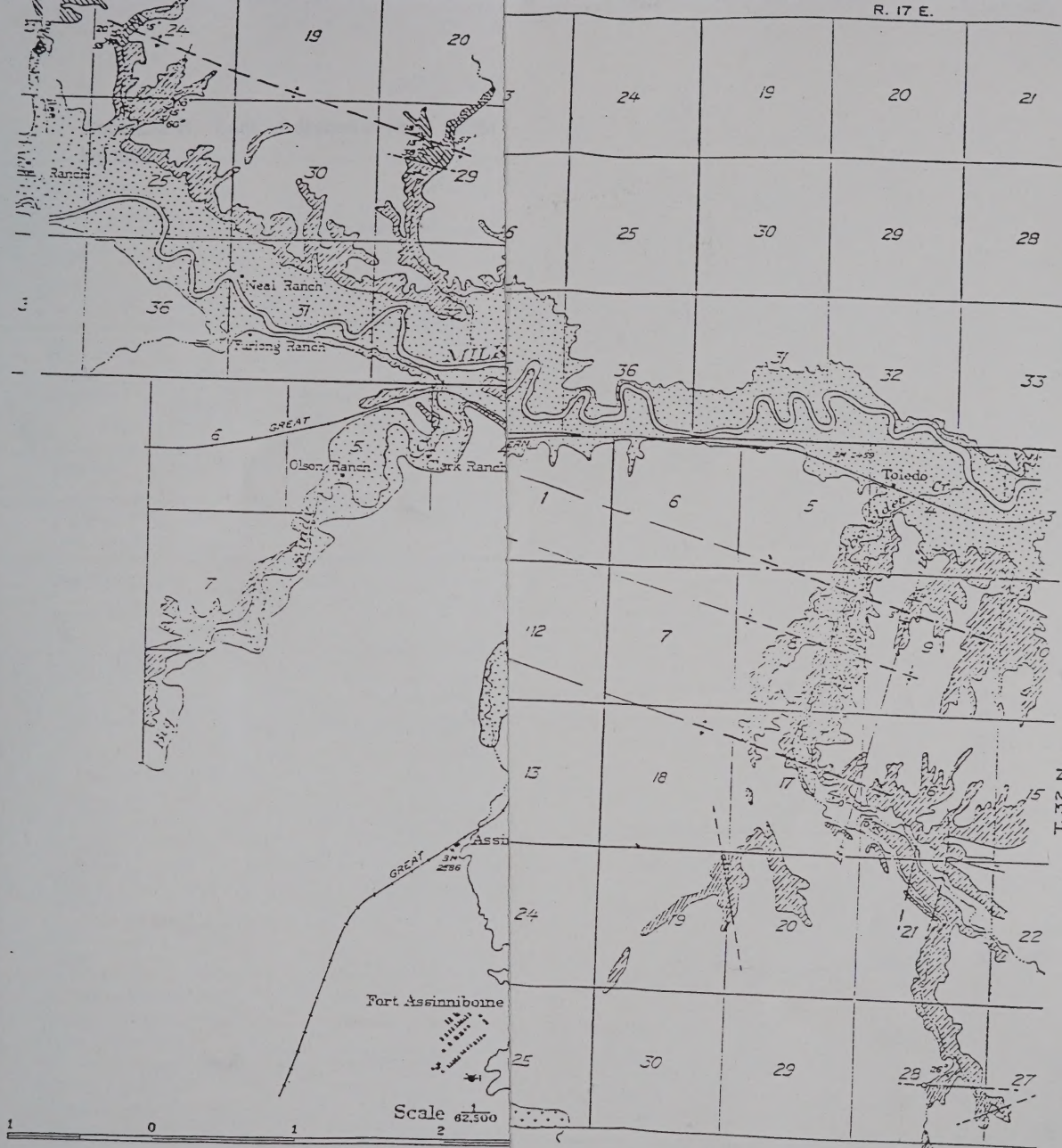
GREAT FALLS • MISSOULA • BILLINGS MONTANA • BOISE IDAHO

LOG OF EXPLORATION BORING

HOLE NO. DH No. 16JOB NO. 72-24SHEET 1 OF 1

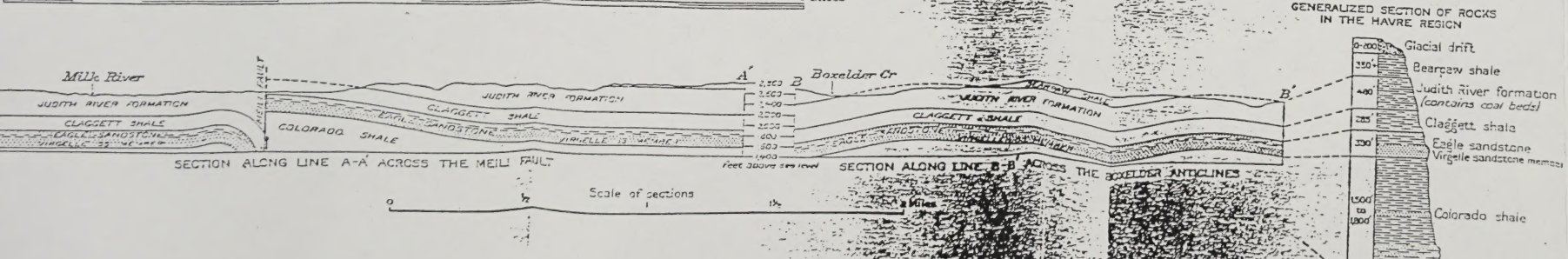
DRILL TYPE SOIL ROCK	Mobile B-52	PROJECT	WASTE WATER TREATMENT PLANT		
SIZE TYPE OF BIT	7-1/2 Inch Diameter Hollow Auger	UNIT	Pipe Line Alignment - Also Center of Lagoon		
CASING SIZE	None	LENGTH	LOCATION Station 70 + 80		
TOTAL NO OF OVERBURDEN SAMPLES TAKEN		NAME OF DRILLER	M. Couture		
Disturbed	2	Undisturbed	0		
TOTAL CORE RECOVERY FOR BORING		ELEVATION TOP OF HOLE	2643.0 GROUNDWATER None		
TOTAL NO CORE BOXES	0	THICKNESS OF OVERBURDEN	10.5'	DEPTH DRILLED INTO ROCK	0
REMARKS		TOTAL DEPTH OF HOLE	10.5'		
		DATE HOLE			
		Started	6-05-72		
		Completed	4-05-72		
		SIGNATURE OF INSPECTOR	M. Knutson		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.3		TOPSOIL, organic matter			
	5		SAND, Silty; some clayey fines, moist, medium loose			
	8			Hand		6.0 - 8.0 : Auger Cuttings
	10.5		CLAY, Silty; moist sandy, medium soft			
				Hand		9.0 - 10.5 : Auger Cuttings



EXPLANATION

- | | | | |
|---------------|------------------------|--|-----------------|
| | | | |
| Alluvium | Bearpaw shale | Axis of anticline (a) and syncline (b) | Horizontal beds |
| | | | |
| Glacial drift | Judith River formation | Fault | Gas well |
| | | | |
| Igneous rocks | Claggett shale | Strike and slip | Small flow |



EXPLANATION			
	Alluvium		Bearpaw shale
	Glacial drift		Judith River formation
	Claggett shale		Eagle sandstone
	Colorado shale		Virgelle sandstone member
	Axis of anticline (a) and syncline (s)		Fault
	Horizontal beds		Gas well

Appendix B. Logs of domestic wells within one mile of the City of Havre sewage sludge lagoon.

1. WELL OWNER Name <u>Wendy R. Roberts</u>		2. WATER LEVEL Water level (ft) <u>12.5</u> (ft above/below surface) If flowing, state in pressure <u>psi</u> Continued on valve <u>yes</u> (water, energy)																																																																																																																															
3. CURRENT MAILING ADDRESS <u>1221 15th St NW</u> <u>Havre, Montana</u>		4. WELL TEST DATA <u>X</u> (none) <u>1</u> (only) (none, (none)) Pumping water level below land surface <u>12.5</u> ft. (ft) (ft. above/below) <u>12.5</u> ft. (ft) <u>10.5</u> ft. (ft) (ft. above/below) <u>10.5</u> ft. (ft)																																																																																																																															
5. WELL LOCATION County <u>H/24</u> Township <u>5N</u> Range <u>16E</u> Section <u>32</u> W <u>12</u> N <u>25</u> W Section <u>32</u> Lot <u>64</u> Block <u>1</u> Roadway <u>1/2 mile 72nd St</u>		6. WAS WELL FLANGED OR ABANDONED? <u>Yes</u> (No) (Yes, how?)																																																																																																																															
7. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐ Other ☐ specify _____		8. DATE COMPLETED <u>12/24/80</u> <u>1/19/81</u>																																																																																																																															
9. DRILLING METHOD <u>Y</u> (none) (none) (none) (none) (none) Other (specify) _____		10. WELL LOG Depth (ft) From <u>0</u> To <u>50.0</u> (formation)																																																																																																																															
11. WELL CONSTRUCTION AND DESCRIPTION <table border="1"> <thead> <tr> <th>Depth (ft)</th> <th>Material</th> <th>Remarks</th> <th>Depth (ft)</th> <th>Material</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>3"</td> <td></td> <td>31</td> <td>1/2"</td> <td></td> </tr> <tr> <td>31</td> <td>3"</td> <td></td> <td>32</td> <td>1/2"</td> <td></td> </tr> <tr> <td>32</td> <td>3"</td> <td></td> <td>33</td> <td>1/2"</td> <td></td> </tr> <tr> <td>33</td> <td>3"</td> <td></td> <td>34</td> <td>1/2"</td> <td></td> </tr> <tr> <td>34</td> <td>3"</td> <td></td> <td>35</td> <td>1/2"</td> <td></td> </tr> <tr> <td>35</td> <td>3"</td> <td></td> <td>36</td> <td>1/2"</td> <td></td> </tr> <tr> <td>36</td> <td>3"</td> <td></td> <td>37</td> <td>1/2"</td> <td></td> </tr> <tr> <td>37</td> <td>3"</td> <td></td> <td>38</td> <td>1/2"</td> <td></td> </tr> <tr> <td>38</td> <td>3"</td> <td></td> <td>39</td> <td>1/2"</td> <td></td> </tr> <tr> <td>39</td> <td>3"</td> <td></td> <td>40</td> <td>1/2"</td> <td></td> </tr> <tr> <td>40</td> <td>3"</td> <td></td> <td>41</td> <td>1/2"</td> <td></td> </tr> <tr> <td>41</td> <td>3"</td> <td></td> <td>42</td> <td>1/2"</td> <td></td> </tr> <tr> <td>42</td> <td>3"</td> <td></td> <td>43</td> <td>1/2"</td> <td></td> </tr> <tr> <td>43</td> <td>3"</td> <td></td> <td>44</td> <td>1/2"</td> <td></td> </tr> <tr> <td>44</td> <td>3"</td> <td></td> <td>45</td> <td>1/2"</td> <td></td> </tr> <tr> <td>45</td> <td>3"</td> <td></td> <td>46</td> <td>1/2"</td> <td></td> </tr> <tr> <td>46</td> <td>3"</td> <td></td> <td>47</td> <td>1/2"</td> <td></td> </tr> <tr> <td>47</td> <td>3"</td> <td></td> <td>48</td> <td>1/2"</td> <td></td> </tr> <tr> <td>48</td> <td>3"</td> <td></td> <td>49</td> <td>1/2"</td> <td></td> </tr> <tr> <td>49</td> <td>3"</td> <td></td> <td>50</td> <td>1/2"</td> <td></td> </tr> </tbody> </table>		Depth (ft)	Material	Remarks	Depth (ft)	Material	Remarks	0	3"		31	1/2"		31	3"		32	1/2"		32	3"		33	1/2"		33	3"		34	1/2"		34	3"		35	1/2"		35	3"		36	1/2"		36	3"		37	1/2"		37	3"		38	1/2"		38	3"		39	1/2"		39	3"		40	1/2"		40	3"		41	1/2"		41	3"		42	1/2"		42	3"		43	1/2"		43	3"		44	1/2"		44	3"		45	1/2"		45	3"		46	1/2"		46	3"		47	1/2"		47	3"		48	1/2"		48	3"		49	1/2"		49	3"		50	1/2"		12. DRILLER'S CERTIFICATION This well was drilled under my jurisdiction and this report is true to the best of my knowledge. <u>Wendy R. Roberts</u> Date <u>12/24/80</u> Signature <u>Wendy R. Roberts</u> Title <u>Owner</u> Address <u>1221 15th St NW</u> City <u>Havre</u> State <u>MT</u> Zip <u>59501</u>	
Depth (ft)	Material	Remarks	Depth (ft)	Material	Remarks																																																																																																																												
0	3"		31	1/2"																																																																																																																													
31	3"		32	1/2"																																																																																																																													
32	3"		33	1/2"																																																																																																																													
33	3"		34	1/2"																																																																																																																													
34	3"		35	1/2"																																																																																																																													
35	3"		36	1/2"																																																																																																																													
36	3"		37	1/2"																																																																																																																													
37	3"		38	1/2"																																																																																																																													
38	3"		39	1/2"																																																																																																																													
39	3"		40	1/2"																																																																																																																													
40	3"		41	1/2"																																																																																																																													
41	3"		42	1/2"																																																																																																																													
42	3"		43	1/2"																																																																																																																													
43	3"		44	1/2"																																																																																																																													
44	3"		45	1/2"																																																																																																																													
45	3"		46	1/2"																																																																																																																													
46	3"		47	1/2"																																																																																																																													
47	3"		48	1/2"																																																																																																																													
48	3"		49	1/2"																																																																																																																													
49	3"		50	1/2"																																																																																																																													
13. WHAT IS THE TEMPERATURE OF THE WATER? Degree Fahrenheit <u>50</u> ☐ Minimum ☐ Maximum		14. SIGNATURE OF WELL OWNER <u>Wendy R. Roberts</u> Date <u>12/24/80</u> Signature <u>Wendy R. Roberts</u> Title <u>Owner</u> Address <u>1221 15th St NW</u> City <u>Havre</u> State <u>MT</u> Zip <u>59501</u>																																																																																																																															

State law requires this well log to be filed by the water well driller within 60 days after completion
MONTANA D.N.R.C.
HAYRE FIELD OFFICE

1. WELL OWNER Name <u>JOHN R. ROBERTS</u> 2. CURRENT MAILING ADDRESS <u>1321 15TH ST. NO</u> <u>HAYRE, MONTANA</u> 3. WELL LOCATION County <u>HILL</u> Township <u>33 NYS</u> Range <u>16 EW</u> <u>1/4 1/4 SE 1/4</u> Section <u>32</u> Lot <u>6</u> Block _____ Subdivision <u>NABOR TRACT #1</u> 4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐ Other ☐ specify _____ 5. DRILLING METHOD ☒ cable, _____ bored, forward rotary, _____ reverse rotary, _____ jetted, other (specify) _____ 6. WELL CONSTRUCTION AND COMPLETION <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Size of drilled hole</th> <th>Size and weight of casing</th> <th>From (feet)</th> <th>To (feet)</th> <th>Perforations Screen</th> <th>Kind Size</th> <th>From (feet)</th> <th>To (feet)</th> </tr> </thead> <tbody> <tr> <td>5 1/4"</td> <td>2 1/2" AFT</td> <td>0</td> <td>33</td> <td>Y</td> <td></td> <td></td> <td></td> </tr> <tr> <td>5 1/4" CD</td> <td>2 1/2" AFT</td> <td>33</td> <td>109 1/2</td> <td></td> <td>3 1/2"</td> <td>80</td> <td>109</td> </tr> <tr> <td>5 1/4" CD</td> <td>2 1/2" AFT</td> <td>10</td> <td>109 1/2</td> <td></td> <td>3 1/2"</td> <td></td> <td></td> </tr> </tbody> </table>	Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	Kind Size	From (feet)	To (feet)	5 1/4"	2 1/2" AFT	0	33	Y				5 1/4" CD	2 1/2" AFT	33	109 1/2		3 1/2"	80	109	5 1/4" CD	2 1/2" AFT	10	109 1/2		3 1/2"			8. WATER LEVEL Static water level <u>34 1/2</u> feet below land surface If flowing; closed-in pressure _____ psi Controlled by: _____ valve, _____ reducers, other, (specify) _____ 9. WELL TEST DATA ☒ pump ☒ bailer other, (specify) _____ Pumping water level below land surface: <u>105</u> ft. after <u>1</u> hrs. <u>CHANGING</u> pumping <u>12</u> gpm <u>105</u> ft. after <u>1 1/2</u> hrs. pumping <u>11 1/2</u> gpm 10. WAS WELL PLUGGED OR ABANDONED? Yes ☒ No ☐ If yes, how? _____ 11. DATE COMPLETED <u>FEBRUARY 8, 1983</u> 12. WELL LOG <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Depth (ft.)</th> <th>From</th> <th>To</th> <th>Formation</th> </tr> </thead> <tbody> <tr><td>0</td><td>2</td><td></td><td>SOIL</td></tr> <tr><td>2</td><td>18</td><td></td><td>GRAVELLY & SANDY BROWN CLAY</td></tr> <tr><td>18</td><td>31</td><td></td><td>GRAVEL, BOULDERS & CLAY</td></tr> <tr><td>31</td><td>32 1/2</td><td></td><td>DENSE BROWNISH-GREEN CLAY</td></tr> <tr><td>32 1/2</td><td>36</td><td></td><td>YELLOWISH-BROWN SHALE</td></tr> <tr><td>36</td><td>38 1/2</td><td></td><td>SANDY BROWN SHALE - COAL SEAM (DEEP)</td></tr> <tr><td>38 1/2</td><td>81 1/2</td><td></td><td>GREEN BLUE-GREEN & SANDY SHALES</td></tr> <tr><td>81 1/2</td><td>90 1/2</td><td></td><td>SHALEY SANDSTONE - WATER 5 1/2 GPM</td></tr> <tr><td>90 1/2</td><td>95</td><td></td><td>SHALEY SANDSTONE - HARD PIRC -</td></tr> <tr><td>95</td><td>101</td><td></td><td>WATER INCREASED TO 5 GPM</td></tr> <tr><td>101</td><td>109 1/2</td><td></td><td>GREEN SANDSTONE - WATER</td></tr> <tr><td>109 1/2</td><td></td><td></td><td>INCREASED TO 6 1/4 GPM</td></tr> <tr><td></td><td></td><td></td><td>GREEN SANDSTONE - WATER</td></tr> <tr><td></td><td></td><td></td><td>YIELD INCREASED TO 10 GPM</td></tr> <tr><td></td><td></td><td></td><td>HARD SHELL ENCOUNTERED AT 109 1/2" TOTAL DEPT</td></tr> <tr><td></td><td></td><td></td><td>(WATER YIELD INCREASED TO 12 GPM AFTER</td></tr> <tr><td></td><td></td><td></td><td>SEALING HOLES) (use separate sheet if necessary) 3" DIAMETER)</td></tr> </tbody> </table> 13. DRILLER'S CERTIFICATION This well was drilled under my jurisdiction and this report is true to the best of my knowledge. <u>MARCH 25, 1984</u> Date <u>HILLINE DRILLING SERVICE</u> PHONE <u>265-4210</u> Firm Name <u>173 6TH S NO HAYRE, MONTANA</u> Address <u>Shirley L. Hill</u> Signature <u>46</u> License No.	Depth (ft.)	From	To	Formation	0	2		SOIL	2	18		GRAVELLY & SANDY BROWN CLAY	18	31		GRAVEL, BOULDERS & CLAY	31	32 1/2		DENSE BROWNISH-GREEN CLAY	32 1/2	36		YELLOWISH-BROWN SHALE	36	38 1/2		SANDY BROWN SHALE - COAL SEAM (DEEP)	38 1/2	81 1/2		GREEN BLUE-GREEN & SANDY SHALES	81 1/2	90 1/2		SHALEY SANDSTONE - WATER 5 1/2 GPM	90 1/2	95		SHALEY SANDSTONE - HARD PIRC -	95	101		WATER INCREASED TO 5 GPM	101	109 1/2		GREEN SANDSTONE - WATER	109 1/2			INCREASED TO 6 1/4 GPM				GREEN SANDSTONE - WATER				YIELD INCREASED TO 10 GPM				HARD SHELL ENCOUNTERED AT 109 1/2" TOTAL DEPT				(WATER YIELD INCREASED TO 12 GPM AFTER				SEALING HOLES) (use separate sheet if necessary) 3" DIAMETER)
Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	Kind Size	From (feet)	To (feet)																																																																																																		
5 1/4"	2 1/2" AFT	0	33	Y																																																																																																					
5 1/4" CD	2 1/2" AFT	33	109 1/2		3 1/2"	80	109																																																																																																		
5 1/4" CD	2 1/2" AFT	10	109 1/2		3 1/2"																																																																																																				
Depth (ft.)	From	To	Formation																																																																																																						
0	2		SOIL																																																																																																						
2	18		GRAVELLY & SANDY BROWN CLAY																																																																																																						
18	31		GRAVEL, BOULDERS & CLAY																																																																																																						
31	32 1/2		DENSE BROWNISH-GREEN CLAY																																																																																																						
32 1/2	36		YELLOWISH-BROWN SHALE																																																																																																						
36	38 1/2		SANDY BROWN SHALE - COAL SEAM (DEEP)																																																																																																						
38 1/2	81 1/2		GREEN BLUE-GREEN & SANDY SHALES																																																																																																						
81 1/2	90 1/2		SHALEY SANDSTONE - WATER 5 1/2 GPM																																																																																																						
90 1/2	95		SHALEY SANDSTONE - HARD PIRC -																																																																																																						
95	101		WATER INCREASED TO 5 GPM																																																																																																						
101	109 1/2		GREEN SANDSTONE - WATER																																																																																																						
109 1/2			INCREASED TO 6 1/4 GPM																																																																																																						
			GREEN SANDSTONE - WATER																																																																																																						
			YIELD INCREASED TO 10 GPM																																																																																																						
			HARD SHELL ENCOUNTERED AT 109 1/2" TOTAL DEPT																																																																																																						
			(WATER YIELD INCREASED TO 12 GPM AFTER																																																																																																						
			SEALING HOLES) (use separate sheet if necessary) 3" DIAMETER)																																																																																																						
7. WHAT IS THE TEMPERATURE OF THE WATER? _____ Degrees Fahrenheit ☐ Measured ☐ Estimated																																																																																																									

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

32 SOUTH EWING

HELENA, MONTANA 59620

449-3962

DNRC

1. WELL OWNER Name <u>DOROTHY KIPP</u>	6. WATER LEVEL Static water level <u>30</u> feet below land surface If flowing, closed-in pressure _____ psi _____ gpm flow through _____ inch pipe Controlled by: _____ valve, _____ reducers, _____ other (if other, specify) _____																																																								
2. CURRENT MAILING ADDRESS <u>STAR RT 36 BOX 289</u> <u>HAVRE, MONTANA</u>	7. WELL TEST DATA <u>X</u> pump <u>X</u> bailer _____ other _____ (if other, specify) _____ Pumping level below land surface: <u>BAILING</u> <u>95</u> ft. after <u>1 1/2</u> hrs. pumping <u>10</u> gpm <u>70</u> ft. after <u>5</u> hrs. pumping <u>7 1/2</u> gpm																																																								
3. WELL LOCATION <table border="1" style="margin: auto; border-collapse: collapse;"> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> </table> SE 1/4 SE 1/4 SE 1/4 Section <u>32</u> Township <u>33</u> NYS Range <u>16</u> E/W County <u>HILL</u> Lot <u>8</u> Block _____ Subdivision <u>OCL HARBOR TRACT 1</u> Well Elevation _____ Accuracy: _____ ± 10' _____ ± 50' _____ ± 100'																										8. WAS WELL PLUGGED OR ABANDONED? Yes <u>X</u> No _____ If yes, how? _____ 9. DATE STARTED <u>OCTOBER 7, 1982</u> DATE COMPLETED <u>OCTOBER 14, 1982</u>																															
4. DRILLING METHOD _____ cable, _____ bored, _____ forward rotary, _____ reverse rotary, _____ jetted. <u>X</u> other (specify) <u>COMBINATION AIR ROTARY/PAVE</u>	10. WELL LOG Depth (ft.) From To Formation <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>0</td><td>2</td><td>SANDY SOIL</td></tr> <tr><td>2</td><td>6</td><td>FIRM SANDY BROWN CLAY</td></tr> <tr><td>6</td><td>26</td><td>BROWN CLAY - SANDY ENTIRELY STREAKS</td></tr> <tr><td>26</td><td>28</td><td>CLAY</td></tr> <tr><td>28</td><td>34</td><td>GREY SANDSTONE - TRACE OF WATER</td></tr> <tr><td>34</td><td>37 1/2</td><td>OLIVE COLORED SHALE</td></tr> <tr><td>37 1/2</td><td>39</td><td>HARD SHELL</td></tr> <tr><td>39</td><td>50</td><td>BROWN BENTONITIC SHALE</td></tr> <tr><td>50</td><td>55</td><td>GREY SANDSTONE - WATER 2 GPM</td></tr> <tr><td>55</td><td>62 1/2</td><td>BLUE SHALE</td></tr> <tr><td>62 1/2</td><td>64</td><td>BROWNISH-GREY SHALE</td></tr> <tr><td>64</td><td>67</td><td>SANDY BROWN SHALE & SHALEY</td></tr> <tr><td>67</td><td>68</td><td>SANDSTONE - WATER YIELD INCREASED TO 2 GPM</td></tr> <tr><td>67</td><td>76</td><td>BLUE SHALE</td></tr> <tr><td>76</td><td>81</td><td>BROWN SHALE (FIRM)</td></tr> <tr><td>81</td><td>97</td><td>BROWN SHALEY SANDSTONE WATER AT 90 FT INCREASED TO 4 GPM</td></tr> <tr><td>97</td><td>111 1/2</td><td>VERY HARD SHELL SANDSTONE - WATER YIELD INCREASED TO APPROX 15 GPM</td></tr> <tr><td>111 1/2</td><td>112 1/2</td><td>VERY HARD SHELL SHALES (BOTTOM)</td></tr> </table> NOTE: HOLE DIAMETER ENLARGED TO 7 7/8" TO 7 9/8" FT LEVEL. CASING INSTALLED WITH PACKER PLACED FROM 79 TO 90 FT LEVEL THEN CASING RAISED & WATER LEVEL BAILED BELOW PACKER. PACKER LOWERED & SAND RACED ABOVE PACKER AND IMMEDIATELY (see separate sheet if necessary) RECENTED ABOVE 79 FT. WITH MATERIAL. ALL WATER YIELDS ABOVE 80 FT SEALED.	0	2	SANDY SOIL	2	6	FIRM SANDY BROWN CLAY	6	26	BROWN CLAY - SANDY ENTIRELY STREAKS	26	28	CLAY	28	34	GREY SANDSTONE - TRACE OF WATER	34	37 1/2	OLIVE COLORED SHALE	37 1/2	39	HARD SHELL	39	50	BROWN BENTONITIC SHALE	50	55	GREY SANDSTONE - WATER 2 GPM	55	62 1/2	BLUE SHALE	62 1/2	64	BROWNISH-GREY SHALE	64	67	SANDY BROWN SHALE & SHALEY	67	68	SANDSTONE - WATER YIELD INCREASED TO 2 GPM	67	76	BLUE SHALE	76	81	BROWN SHALE (FIRM)	81	97	BROWN SHALEY SANDSTONE WATER AT 90 FT INCREASED TO 4 GPM	97	111 1/2	VERY HARD SHELL SANDSTONE - WATER YIELD INCREASED TO APPROX 15 GPM	111 1/2	112 1/2	VERY HARD SHELL SHALES (BOTTOM)		
0	2	SANDY SOIL																																																							
2	6	FIRM SANDY BROWN CLAY																																																							
6	26	BROWN CLAY - SANDY ENTIRELY STREAKS																																																							
26	28	CLAY																																																							
28	34	GREY SANDSTONE - TRACE OF WATER																																																							
34	37 1/2	OLIVE COLORED SHALE																																																							
37 1/2	39	HARD SHELL																																																							
39	50	BROWN BENTONITIC SHALE																																																							
50	55	GREY SANDSTONE - WATER 2 GPM																																																							
55	62 1/2	BLUE SHALE																																																							
62 1/2	64	BROWNISH-GREY SHALE																																																							
64	67	SANDY BROWN SHALE & SHALEY																																																							
67	68	SANDSTONE - WATER YIELD INCREASED TO 2 GPM																																																							
67	76	BLUE SHALE																																																							
76	81	BROWN SHALE (FIRM)																																																							
81	97	BROWN SHALEY SANDSTONE WATER AT 90 FT INCREASED TO 4 GPM																																																							
97	111 1/2	VERY HARD SHELL SANDSTONE - WATER YIELD INCREASED TO APPROX 15 GPM																																																							
111 1/2	112 1/2	VERY HARD SHELL SHALES (BOTTOM)																																																							
5. WELL CONSTRUCTION AND COMPLETION <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>Size of drilled hole</th> <th>Size and weight of casing</th> <th>From (feet)</th> <th>To (feet)</th> <th>Perforations Screen</th> <th>Kind Size</th> <th>From (feet)</th> <th>To (feet)</th> </tr> <tr> <td>9 1/2"</td> <td></td> <td>0</td> <td>33</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7 7/8"</td> <td></td> <td>33</td> <td>79 1/2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>6 1/2"</td> <td></td> <td>79 1/2</td> <td>115</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>5 1/2" O.D.</td> <td>1 foot 178 RML ABOVE GROUND</td> <td></td> <td>12</td> <td></td> <td>3/4" DRILLED</td> <td>81</td> <td>112</td> </tr> <tr> <td>5 3/4" O.D.</td> <td>PVC 160'</td> <td></td> <td>11 1/2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>5 1/2" O.D.</td> <td>PVC 200'</td> <td></td> <td>75 1/2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	Kind Size	From (feet)	To (feet)	9 1/2"		0	33					7 7/8"		33	79 1/2					6 1/2"		79 1/2	115					5 1/2" O.D.	1 foot 178 RML ABOVE GROUND		12		3/4" DRILLED	81	112	5 3/4" O.D.	PVC 160'		11 1/2					5 1/2" O.D.	PVC 200'		75 1/2					11. DRILLER'S CERTIFICATION OF BEGONITE & FILL ABOVE This well was drilled under my jurisdiction and this report is true to the best of my knowledge. <u>November 21, 1982</u> Date <u>41-LINE DRILLING SERVICE</u> P. 265-4210 Firm Name <u>1175 6TH ST. N. HAVRE, MONTANA</u> Address <u>Robert Quinn</u> <u>46</u> Signature License No.
Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	Kind Size	From (feet)	To (feet)																																																		
9 1/2"		0	33																																																						
7 7/8"		33	79 1/2																																																						
6 1/2"		79 1/2	115																																																						
5 1/2" O.D.	1 foot 178 RML ABOVE GROUND		12		3/4" DRILLED	81	112																																																		
5 3/4" O.D.	PVC 160'		11 1/2																																																						
5 1/2" O.D.	PVC 200'		75 1/2																																																						
Was casing left open end? <u>X</u> Yes _____ No _____ Was a packer or seal used? <u>X</u> Yes From <u>79</u> to <u>90</u> ft _____ No _____ If so, what material <u>UNIQUE PLASTIC & ARSLAD</u> _____ Was the well gravel packed? _____ Yes _____ No _____ Was the well grouted? <u>X</u> Yes _____ No _____ To what depth? <u>FROM APPROX 8 TO 12 WITH CEMENT, 18 TO 20 WITH BENTONITE & FILL</u> Material used in grouting <u>5 TO 7 1/2" WITH CEMENT</u> Well head completion: Pileless adapter _____ 12 in. above grade <u>X</u> _____ other <u>X</u> _____ (If other, specify) <u>CAMPBELL WELL CAP</u> Pump horsepower <u>1/2</u> pump type <u>SUBMERSIBLE</u> Pump intake level <u>109</u> feet below land surface Power (electric, diesel, etc.) <u>ELECTRIC</u>																																																									

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

32 SOUTH EWING

HELENA, MONTANA 59601

449-3634

DNRC

JUL 31 1989

WELL LOG REPORT

73652-405

MONTANA D.N.R.C.
HAYES FIELD OFFICE

State form to be filed by the water well driller within 60 days after completion of the well.

8-3-89

1. WELL OWNER Name <u>WILLIAM SIMPSON</u>		7. WELL CONSTRUCTION AND COMPLETION			
2. CURRENT MAILING ADDRESS <u>Box 345</u> <u>HAYES, MT.</u>		Size of drilled hole 10"	Size and PSI Rating of casing 6" 250 3.001	From (feet) 10	To (feet) 39
3. WELL LOCATION County <u>H. 11</u> Township <u>33N</u> N/S Range <u>10E</u> E/W 10 1/4 NW 1/4 NW 1/4 Section <u>32</u> Lot _____ Block _____ Subdivision _____ Tract Number _____		Perforations _____ and/or _____ Screen _____ Kind Size From (feet) To (feet) 4" 375 415			
4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐ Other ☐ specify _____		Was casing left open end? ☒ Yes _____ No Was a packer or seal used? ☒ Yes _____ No If so, what material _____ Was the well gravel packed? _____ Yes _____ No To what depth was the well grouted? _____ ft Material used in grouting <u>HEAVY CEMENT</u> Well head completion: Pitless adapter _____ Top casing 18 in. or greater above grade _____ Yes _____ No			
5. DRILLING METHOD _____ cable, ☒ air rotary, _____ forward rotary, _____ reverse rotary, _____ jetted, _____ other (specify) _____		8. WELL TEST DATA The pump test information request in this section is required for all wells. All depth measurements shall be from the top of the well casing unless otherwise specified. All wells under 100 gpm must be tested for a minimum of one hour and provide the following information: a) Air ☒ Pump _____ Bailer _____ b) Static water level immediately before testing <u>290</u> ft. If flowing; closed-in pressure _____ psi _____ gpm Controlled by: _____ valve, _____ reducers, _____ other (specify) _____ c) Depth at which pump is set for test <u>370</u> d) The pumping rate and means of discharge (i.e., bailing, airlift, pumping) _____ gpm e) Maximum drawdown during the test _____ ft f) Duration of test: Pumping time <u>2</u> hrs Recovery time <u>1</u> hrs g) Recovery water level <u>310</u> ft Amount of time after pumping recovery level water data was taken _____ hrs Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form included in each packet of well logs. NOTE: All wells shall be equipped with an access port 1/2 inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.			
6. WELL LOG Depth (ft.) From To Formation		9. WAS WELL PLUGGED OR ABANDONED? _____ Yes _____ No If yes, how? _____			
0 16 BROWN CLAY 16 18 BROWN SHALE 18 19 COAL 19 24 BROWN SHALE 24 45 GRAY SHALE 45 49 BROWN SHALE & COAL 49 63 GRAY SHALE 63 66 BROWN SHALE 66 71 GRAY SHALE 71 73 BROWN SHALE & COAL 73 85 GRAY SHALE 85 102 SANDSTONE 102 103 ROCK LAYER 103 117 GRAY SHALE 117 118 BROWN SHALE 118 120 GRAY SANDSTONE 120 141 GRAY SHALE 141 142 ROCK LAYER 142 145 BROWN SANDSTONE 145 155 GRAY SHALE 155 157 ROCK LAYER 157 185 GRAY SHALE 185 210 BROWN SHALE 210 215 GRAY SANDSTONE 215 230 GRAY SHALE 230 240 BROWN SHALE 240 250 GRAY SHALE 250 255 BROWN SANDSTONE 255 270 GRAY SHALE 270 275 GRAY SANDSTONE 275 294 GRAY SHALE 294 300 BROWN SHALE 300 303 GRAY SANDSTONE 303 304 ROCK LAYER 304 320 GRAY SHALE 320 332 BROWN SHALE 332 356 SANDY GRAY SHALE 356 375 BROWN SHALE 375 415 BROWN SANDSTONE WATER 415 421 GRAY SHALE		10. DATE COMPLETED <u>5/23/89</u> 11. DRILLER/CONTRACTOR'S CERTIFICATION This well was drilled under my jurisdiction and this report is true to the best of my knowledge. Date <u>7/3/89</u> Firm Name <u>Jacobson Drilling</u> Address <u>509, Maple Dr. Hayes 59620-240</u> Signature <u>Robert Jacobson</u> License No. <u>351</u>			
ATTACH ADDITIONAL SHEETS IF NECESSARY					

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

DRAINAGE = FD

1520 EAST SIXTH AVENUE

HELENA, MONTANA 59620-2301

444-6610

DNRC

m: 44712

1. WELL OWNER Name <u>John Keeling</u>	f) Duration of test: Pumping time <u>2</u> hrs. g) Recovery time _____ hrs. h) Recovery water level <u>220</u> ft. at <u>1</u> hrs. after pumping stopped. Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form. NOTE: All wells shall be equipped with an access port 1/2 inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.																																																																																																										
2. CURRENT MAILING ADDRESS <u>P.O. Box 1944</u> <u>Haure MT 59501</u>	11. WAS WELL PLUGGED OR ABANDONED? Yes ☒ No ☐ If yes, how? _____																																																																																																										
3. WELL LOCATION Twp <u>17N</u> <u>NE</u> <u>NE</u> <u>NE</u> Section <u>32</u> Township <u>33</u> <u>NWS</u> Range <u>16E</u> <u>EW</u> County <u>HILL</u> Gov'n't Lot _____, or Lot _____, Block _____ Subdivision Name _____ Tract Number <u>1</u>																																																																																																											
4. PROPOSED USE: Domestic ☒ Stock ☐ Irrigation ☐ Other ☐ specify _____																																																																																																											
5. TYPE OF WORK: New well ☒ Method: Dug ☐ Bored ☐ Deepened ☐ Cable ☐ Driven ☐ Reconditioned ☐ Rotary ☒ Jetted ☐																																																																																																											
6. DIMENSIONS: Diameter of Hole Dia. <u>10</u> in. from <u>0</u> ft. to <u>50</u> ft. Dia. <u>6</u> in. from <u>50</u> ft. to <u>462</u> ft. Dia. _____ in. from _____ ft. to _____ ft.																																																																																																											
7. CONSTRUCTION DETAILS: Casing: Steel Dia. <u>6 5/8</u> from <u>1.5</u> ft. to <u>50</u> ft. Threaded ☐ Welded ☒ Dia. _____ from _____ ft. to _____ ft. Type <u>XXXXX</u> Wall Thickness <u>.250</u> Casing: Plastic Dia. <u>4.5</u> from <u>42</u> ft. to <u>462</u> ft. Weight <u>SDR 20</u> Dia. _____ from _____ ft. to _____ ft. PERFORATIONS: Yes ☒ No ☐ Type of perforator used <u>DRILL</u> Size of perforations <u>1/4</u> in. by _____ in. _____ perforations from <u>385</u> ft. to <u>401</u> ft. _____ perforations from <u>402</u> ft. to <u>455</u> ft. _____ perforations from _____ ft. to _____ ft. SCREENS: Yes ☐ No ☒ Manufacturer's Name _____ Model No. _____ Type _____ Slot size _____ from _____ ft. to _____ ft. Dia. _____ Slot size _____ from _____ ft. to _____ ft. GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____ Gravel placed from _____ ft. to _____ ft. GROUTED: To what depth? <u>50</u> ft. Material used in grouting <u>NEAT CEMENT</u>																																																																																																											
8. WELL HEAD COMPLETION: Pitless Adapter ☒ Yes ☐ No																																																																																																											
9. PUMP (if installed) Manufacturer's name <u>GOULDS</u> Type <u>SUB.</u> Model No. <u>5ES104.12</u> HP. <u>1</u>																																																																																																											
10. WELL TEST DATA The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing. All wells under 100 gpm must be tested for a minimum of one hour and provide the following information: a) Air ☒ Pump _____ Baller _____ ft. If flowing; closed-in pressure _____ psi. _____ gpm. Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____ c) Depth at which pump is set for test <u>340</u> d) The pumping rate: <u>8</u> gpm. e) Pumping water level <u>340</u> ft. at <u>2</u> hrs. after pumping began.																																																																																																											
12. WELL LOG <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Depth (ft.)</th> <th>From</th> <th>To</th> <th>Formation</th> </tr> </thead> <tbody> <tr><td>0</td><td>17</td><td>SAND & BOULDERS</td></tr> <tr><td>17</td><td>34</td><td>SANDY CLAY</td></tr> <tr><td>34</td><td>60</td><td>BROWN SHALE</td></tr> <tr><td>60</td><td>68</td><td>GRAY SHALE</td></tr> <tr><td>68</td><td>73</td><td>GRAY SANDSTONE</td></tr> <tr><td>73</td><td>80</td><td>BROWN SHALE</td></tr> <tr><td>80</td><td>82</td><td>GRAY SHALE & COAL</td></tr> <tr><td>82</td><td>85</td><td>GRAY SHALE</td></tr> <tr><td>85</td><td>85 1/2</td><td>ROCK LAYER</td></tr> <tr><td>85 1/2</td><td>93</td><td>BROWN SHALE</td></tr> <tr><td>93</td><td>95</td><td>GRAY SHALE</td></tr> <tr><td>95</td><td>98</td><td>SANDY GRAY SHALE</td></tr> <tr><td>98</td><td>120</td><td>GRAY SANDSTONE</td></tr> <tr><td>120</td><td>155</td><td>BROWN SHALE</td></tr> <tr><td>155</td><td>157</td><td>ROCK LAYER</td></tr> <tr><td>157</td><td>174</td><td>BROWN SHALE</td></tr> <tr><td>174</td><td>175</td><td>ROCK LAYER</td></tr> <tr><td>175</td><td>188</td><td>BROWN SHALE</td></tr> <tr><td>188</td><td>193</td><td>SANDSTONE</td></tr> <tr><td>193</td><td>204</td><td>BROWN SHALE</td></tr> <tr><td>204</td><td>208</td><td>SANDSTONE</td></tr> <tr><td>208</td><td>214</td><td>BROWN SHALE</td></tr> <tr><td>214</td><td>238</td><td>GRAY SANDSTONE</td></tr> <tr><td>238</td><td>243</td><td>ROCK LAYER</td></tr> <tr><td>243</td><td>250</td><td>GRAY SANDSTONE</td></tr> <tr><td>250</td><td>355</td><td>BROWN SHALE</td></tr> <tr><td>355</td><td>370</td><td>GRAY SANDSTONE</td></tr> <tr><td>370</td><td>373</td><td>BROWN SHALE</td></tr> <tr><td>373</td><td>377</td><td>BROWN SANDSTONE</td></tr> <tr><td>377</td><td>385</td><td>GRAY SANDSTONE</td></tr> <tr><td>385</td><td>401</td><td>BROWN SANDSTONE & WATER</td></tr> <tr><td>401</td><td>402</td><td>ROCK LAYER</td></tr> <tr><td>402</td><td>455</td><td>BROWN SANDSTONE & WATER</td></tr> <tr><td>455</td><td>462</td><td>BROWN SHALE</td></tr> </tbody> </table> RECEIVED MAY 15 1990 MONTANA D.N.R.C. HAURE FIELD OFFICE ATTACH ADDITIONAL SHEETS IF NECESSARY		Depth (ft.)	From	To	Formation	0	17	SAND & BOULDERS	17	34	SANDY CLAY	34	60	BROWN SHALE	60	68	GRAY SHALE	68	73	GRAY SANDSTONE	73	80	BROWN SHALE	80	82	GRAY SHALE & COAL	82	85	GRAY SHALE	85	85 1/2	ROCK LAYER	85 1/2	93	BROWN SHALE	93	95	GRAY SHALE	95	98	SANDY GRAY SHALE	98	120	GRAY SANDSTONE	120	155	BROWN SHALE	155	157	ROCK LAYER	157	174	BROWN SHALE	174	175	ROCK LAYER	175	188	BROWN SHALE	188	193	SANDSTONE	193	204	BROWN SHALE	204	208	SANDSTONE	208	214	BROWN SHALE	214	238	GRAY SANDSTONE	238	243	ROCK LAYER	243	250	GRAY SANDSTONE	250	355	BROWN SHALE	355	370	GRAY SANDSTONE	370	373	BROWN SHALE	373	377	BROWN SANDSTONE	377	385	GRAY SANDSTONE	385	401	BROWN SANDSTONE & WATER	401	402	ROCK LAYER	402	455	BROWN SANDSTONE & WATER	455	462	BROWN SHALE
Depth (ft.)	From	To	Formation																																																																																																								
0	17	SAND & BOULDERS																																																																																																									
17	34	SANDY CLAY																																																																																																									
34	60	BROWN SHALE																																																																																																									
60	68	GRAY SHALE																																																																																																									
68	73	GRAY SANDSTONE																																																																																																									
73	80	BROWN SHALE																																																																																																									
80	82	GRAY SHALE & COAL																																																																																																									
82	85	GRAY SHALE																																																																																																									
85	85 1/2	ROCK LAYER																																																																																																									
85 1/2	93	BROWN SHALE																																																																																																									
93	95	GRAY SHALE																																																																																																									
95	98	SANDY GRAY SHALE																																																																																																									
98	120	GRAY SANDSTONE																																																																																																									
120	155	BROWN SHALE																																																																																																									
155	157	ROCK LAYER																																																																																																									
157	174	BROWN SHALE																																																																																																									
174	175	ROCK LAYER																																																																																																									
175	188	BROWN SHALE																																																																																																									
188	193	SANDSTONE																																																																																																									
193	204	BROWN SHALE																																																																																																									
204	208	SANDSTONE																																																																																																									
208	214	BROWN SHALE																																																																																																									
214	238	GRAY SANDSTONE																																																																																																									
238	243	ROCK LAYER																																																																																																									
243	250	GRAY SANDSTONE																																																																																																									
250	355	BROWN SHALE																																																																																																									
355	370	GRAY SANDSTONE																																																																																																									
370	373	BROWN SHALE																																																																																																									
373	377	BROWN SANDSTONE																																																																																																									
377	385	GRAY SANDSTONE																																																																																																									
385	401	BROWN SANDSTONE & WATER																																																																																																									
401	402	ROCK LAYER																																																																																																									
402	455	BROWN SANDSTONE & WATER																																																																																																									
455	462	BROWN SHALE																																																																																																									
13. DATE COMPLETED <u>9/27/89</u>																																																																																																											
14. DRILLER/CONTRACTOR'S CERTIFICATION This well was drilled under my jurisdiction and this report is true to the best of my knowledge. <u>Dr. J. Jacobson</u> = FD Date <u>10/1/89</u> Firm Name <u>Jacobson Drilling Co.</u> Address <u>1609 Maple Dr. Haure 265-4245</u> Signature <u>Robert Jacobson</u> License No. <u>339</u>																																																																																																											

TEST BORING LOG

Appendix C. Test boring and well logs of holes drilled for the current hydrogeological study of the City of Havre sewage sludge lagoon.

Date (M/D/Y) 10/1/02 Well number 102
 Surface Elevation 2000 Data(s) 102(1, 2)
 Driller Name CHILLING, SLOAN ET Logged by 2/10/02
 Hole Dia. 4.125" Drill Method AIR-DRY
 Casing (type, depth) N/A

DEPTH (FEET)	ELEV. (FEET)	GRAPHIC LOG	MATERIALS DESCRIPTION
0			TOPSOIL - MEDIUM BROWN SILTY LOAM
2			HAZARD: CARBONATE RICH GRAVELLY SILT AND SAND - NO SOIL
4			GRAYISH TAN, SILTY MEDIUM SAND WITH MIDDLE GRAVEL AND COBBLES, BITS OF COAL HERE AND THERE, GLACIAL
6			4-1/2" SAND AND GRAVEL, LOOSE, CLEAN, GRADES TO LIGHT GRAY, LOOSE, CLEAN SAND
8			GRAY BROWN CLAY SHALE INTERBEDDED WITH SANDSTONE, SANDSTONE IS NOT RESISTANT, CONTAINS MINOR LIMONITE STAINING, ABOUT 1/8" SANDY
10			
12			
14			
16			
18			
20			LOOSE, MEDIUM TO FINE GRAINED TAN SAND
22			GRAY CLAY SHALE - NO SOIL
24			BUSTY, SILTY CLAY SHALE
26			LIGHT GRAY, FINE GRAINED SILTY SAND
28			
30			GRAY CLAY SHALE
32			
34			
36			
38			
40			
42			
44			
46			
48			
50			NO FREE WATER OBSERVED - HOLE PLUGGED WITH MIXTURE OF CUTTINGS AND 100 BAGS OF AN GRANULAR PORTLAND CEMENT

TEST BORING LOG

Project Name HAYRE SLUDGE LAGOON
 (TWP, RNG, Sec.) T33N, R16E, SE1/4NE1/4, 32
 Grid (N,S) _____ (E,W) _____
 Surface Elevation 2656
 Driller SHARP DRILLING, SIDNEY MT.
 Hole Dia. 6 1/4"

Project number 9365
 Well number HSL - 1
 Date(s) 10/21/93
 Logged By B. SIEGMUND
 Drill Method AIR ROTARY
 Casing (type, depth) N/A

DEPTH (FEET)	ELEV. (FEET)	GRAPHIC LOG	MATERIALS DESCRIPTION
			TOPSOIL: MEDIUM BROWN SILTY LOAM.
			HARDPAN: CARBONATE RICH GRAVELLY SILT AND SAND, GRAY-BROWN
5			GRAYISH TAN, SILTY MEDIUM SAND WITH MINOR GRAVEL AND COBBLES, BITS OF COAL HERE AND THERE; GLACIAL.
10			TAN SAND AND GRAVEL, LOOSE, CLEAN, GRADES TO LIGHT GRAY, LOOSE, CLEAN SAND
15			GRAY-BROWN CLAY/SHALE INTERBEDDED WITH SANDSTONE. SANDSTONE IS VERY RESISTANT, CONTAINS MINOR LIMONITE STAINS, JUDITH RIVER Fm?
20			
25			LOOSE, MEDIUM TO FINE GRAINED TAN SAND
30			GRAY CLAY SHALE - POOR RETURN
			RUSTY, SILTY CLAY SHALE
			LIGHT GRAY, FINE GRAINED SILTY SAND
			GRAY CLAY SHALE
35			
40			
45			
50			NO FREE WATER OBSERVED. HOLE PLUGGED WITH MIXTURE OF CUTTINGS AND TWO BAGS OF #8 GRANULAR BENTONITE.



Damschen & Associates, Inc.

CONSULTING ENGINEERS

•2030 11th Ave., Suite 11•
 •HELENA, MONTANA•

PAGE 1 OF 1

TEST BORING LOG

Project Name HAVRE SLUDGE LAGOON
 (TWP, RNG, Sec.) T33N, R16E, SE1/4NE1/4, 32
 Grid (N,S) _____ (E,W) _____
 Surface Elevation 2647.5
 Driller SHARP DRILLING, SIDNEY MT.
 Hole Dia. 6 1/4"

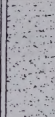
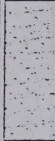
Project number 93-65
 Well number HSL - 1/MW - 1
 Date(s) 10/21/93
 Logged By B. SIEGMUND
 Drill Method AIR ROTARY
 Casing (type, depth) 2" PVC, 20'

DEPTH (FEET)	ELEV. (FEET)	GRAPHIC LOG	MATERIALS DESCRIPTION	WELL CONST. DETAILS
0			TOPSOIL: LIGHT BROWN SANDY LOAM	
0			GRAVELLY GRAY CARBONATE RICH HARDPAN	
5			STICKY BROWN SANDY CLAY AND SILT; POORLY SORTED; GLACIAL	
10			BROWN SAND, MOIST, BECOMING WETTER WITH DEPTH, CRETACEOUS JUDITH RIVER Fm?	
15				
20				
25			GRAY-BROWN CLAY	
25			RESISTANT SANDSTONE, REFUSAL AT 26'	
30			COMPLETED AS MONITORING WELL WITH 2" JOHNSON FLUSH- THREADED SCHEDULE 40 PVC CASING AND SCREEN. SCREEN LENGTH 5 FEET, 0.010" SLOTS WITH 20/40 CSSI SILICA SAND TO ONE FOOT OVER SCREEN, ONE BAG ENVIROPLUG BENTONITE MEDIUM PELLETS, GROUT TO SURFACE. PROTECTIVE CASING OF 6" SQUARE STEEL 5 FEET LONG. FINISHED WITH 2 FOOT SQUARE CONCRETE PROTECTIVE PAD.	
35				
40				
45				
50				

TEST BORING LOG

Project Name HAVRE SLUDGE LAGOON
 (TWP, RNG, Sec.) T33N, R16E, SE1/4NE1/4, 32
 Grid (N,S) _____ (E,W) _____
 Surface Elevation 2630
 Driller SHARP DRILLING, SIDNEY MT.
 Hole Dia. 6 1/4"

Project number 93-65
 Well number HSL - 3
 Date(s) 10/21/93
 Logged By B. SIEGMUND
 Drill Method AIR ROTARY
 Casing (type, depth) _____

DEPTH (FEET)	ELEV. (FEET)	GRAPHIC LOG	MATERIALS DESCRIPTION
5			LIGHT GRAY, MEDIUM-GRAINED SAND
10			DAMP YELLOW-BROWN, SILTY FINE SAND
15			LIGHT GRAY FINE GRAINED SAND
20			BROWN TO TAN STICKY, SANDY CLAY
25			STICKY BROWN SANDY CLAY, POOR RETURN
30			COARSE TAN AND BROWN SAND, POOR RETURN BECAUSE OF STICKY CLAY ABOVE, SAND APPEARS TO BE CLEAN BUT MAY CONTAIN A FEW THIN CLAY BEDS. SAND IS RELATIVELY DRY.
35			
40			NO FREE WATER ENCOUNTERED. HOLE PLUGGED WITH MIXTURE OF CUTTINGS AND TWO BAGS OF #8 GRANULAR BENTONITE.
45			
50			



Damschen & Associates, Inc.

CONSULTING ENGINEERS
 •2030 11th Ave., Suite 11•
 •HELENA, MONTANA•

PAGE 1 OF 1

TEST BORING LOG

Project Name HAVRE SLUDGE LAGOON Project number 93-65
 (TWP, RNG, Sec.) T33N.R16E.SE1/4NE1/4.32 Well number HSL - 4/MW - 2
 Grid (N,S) _____ (E,W) _____ Date(s) 10/21/93
 Surface Elevation 2643 Logged By B. SIEGMUND
 Driller SHARP DRILLING, SIDNEY MT. Drill Method AIR ROTARY
 Hole Dia. 6 1/4" Casing (type, depth) 2" PVC, 22'

DEPTH (FEET)	ELEV. (FEET)	GRAPHIC LOG	MATERIALS DESCRIPTION	WELL CONST. DETAILS
5			TOPSOIL, SILTY, GRAVELLY LOAM, MEDIUM BROWN	
			CARBONATE RICH GRAVEL AND SAND	
10			BROWN SAND WITH MINOR GRAVEL, GRADES WITH DEPTH TO GRAY-TAN SAND, MEDIUM TO FINE GRAINED, BECOMES WETTER WITH DEPTH, SATURATED AT 10'.	
20				
25			BROWN CLAY, SATURATED, POSSIBLY GLACIAL GROUND MORaine.	
30			COMPLETED AS MONITORING WELL WITH 2" JOHNSON FLUSH-THREADED SCHEDULE 40 PVC CASING AND SCREEN. SCREEN LENGTH 3 FEET, 0.010" SLOTS WITH 20/40 CSSI SILICA SAND TO ONE FOOT OVER SCREEN, ONE BAG ENVIROPLUG BENTONITE MEDIUM PELLETS, GROUT TO SURFACE. PROTECTIVE CASING OF 6" SQUARE STEEL 5 FEET LONG. FINISHED WITH 2 FOOT SQUARE CONCRETE PROTECTIVE PAD.	
35				
40				
45				
50				

Appendix D. Analytical reports of ground-water chemistry from two samples taken from wells proximal to the City of Havre sewage sludge lagoon.

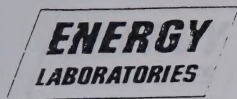
TO: Bruce Berglund
ANALYST: Carlsch & Associates
P.O. Box 4817
Helena, MT 59604

LAB NO.: 82-0208
DATE: 11/20/93 JHW

WATER ANALYSIS

Havre Sludge Pond, MW-1
Sampled 10/22/93
Submitted 10/22/93

	mg/L (ppm)	Date Analyzed
Hardness (Calcium & Magnesium)	450	11/01/93
<u>Traceable Metals</u>		
Arsenic	<0.005	11/08/93
Chromium	<0.01	10/29/93
Nickel	0.02	10/29/93



ENERGY LABORATORIES, INC.

P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6025
FAX (406) 252-6069 • 1-800-735-4469

LABORATORY REPORT

TO: Bruce Siegmund
ADDRESS: Damschen & Associates
P.O. Box 4817
Helena, MT 59604

LAB NO.: 93-52008
DATE: 11/30/93 jmw

WATER ANALYSIS

Havre Sludge Pond, MW-1
Sampled 10/22/93
Submitted 10/26/93

	<u>mg/l (ppm)</u>	<u>Date Analyzed</u>
Nitrate plus Nitrite as N	480	11/03/93
<u>Dissolved Metals</u>		
Arsenic	<0.005	11/08/93
Chromium	<0.01	10/29/93
Nickel	0.02	10/29/93



ENERGY LABORATORIES, INC.

P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE 406/252-6025
FAX 406/252-6059 • 1-800-725-4469

LABORATORY REPORT

TO: Bruce Siegmund
ADDRESS: Damschen & Associates
P.O. Box 4817
Helena, MT 59604

LAB NO.: 93-52009
DATE: 11/30/93 jmw

WATER ANALYSIS

Havre Sludge Pond, MW-2
Sampled 10/22/93
Submitted 10/26/93

	<u>mg/l (ppm)</u>	<u>Date Analyzed</u>
Nitrate plus Nitrite as N	39.4	11/03/93
<u>Dissolved Metals</u>		
Arsenic	<0.005	11/08/93
Chromium	0.01	10/29/93
Nickel	<0.01	10/27/93



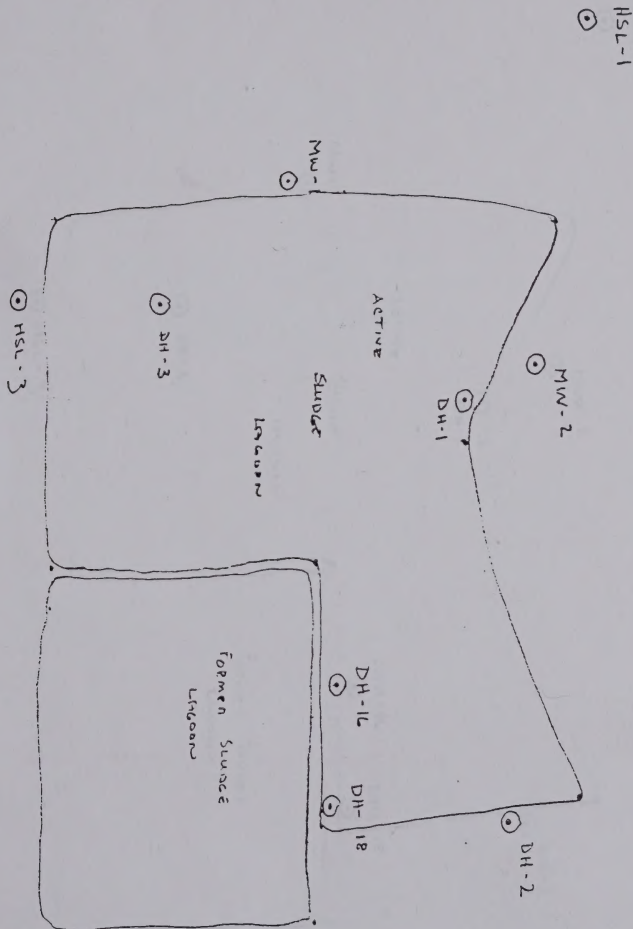
DAMSCHE & ASSOCIATES, INC.

CONSULTING ENGINEERS

PROJECT HAUPPE SLUDGE

PROJ. NO. _____ PAGE 1

DATE _____ BY: _____ CK: _____



700'

APPENDIX C

**PLAN SHEETS
(DETACHED)**

